(Third Edition, 25,000, March, 1909.)

New Zealand Department of Agriculture.

DIVISION OF BIOLOGY AND HORTICULTURE.

T. W. KIRK, F.L.S., Government Biologist, Chief of Division.

BULLETIN No. 18.

BEE-CULTURE.

I. Advice to Beginners.
II. Practical Advice.
III. Bees in Relation to Flowers and Fruit-culture.
IV. Bees in Relation to Agriculture.

By ISAAC HOPKINS, Apiculturist.

ILLUSTRATED.

BY DIRECTION OF THE

Right Hon. Sir J. G. WARD, P.C., K.C.M.G., Prime Minister, Minister of Agriculture.

WELLINGTON.
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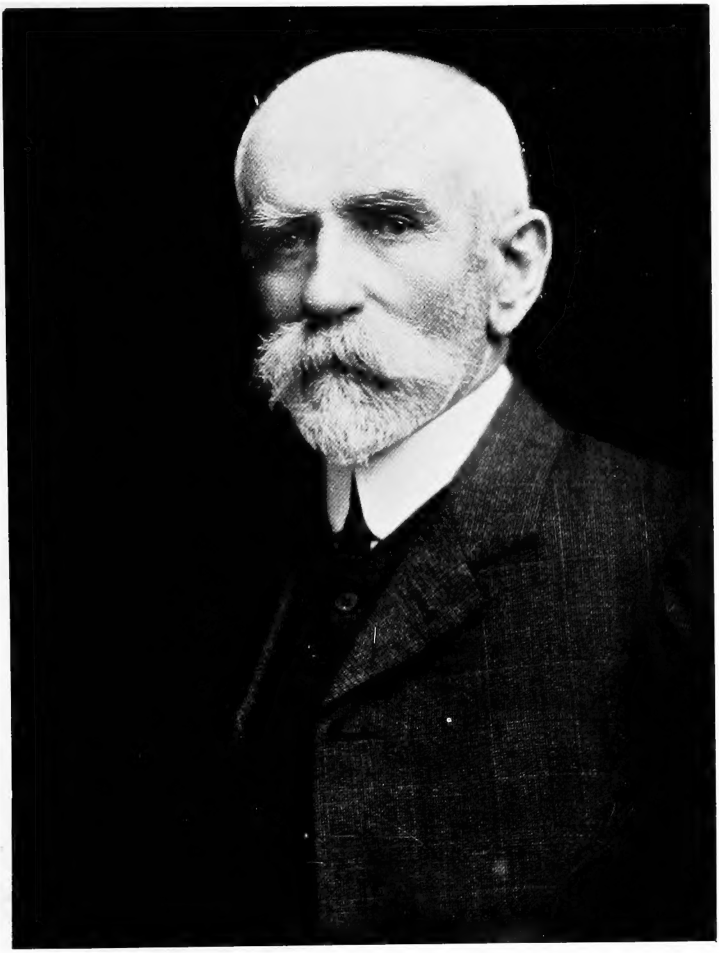
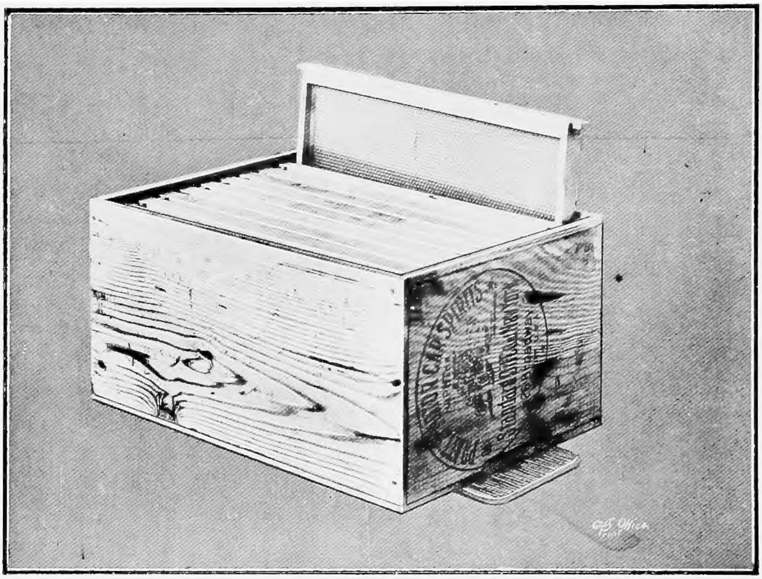
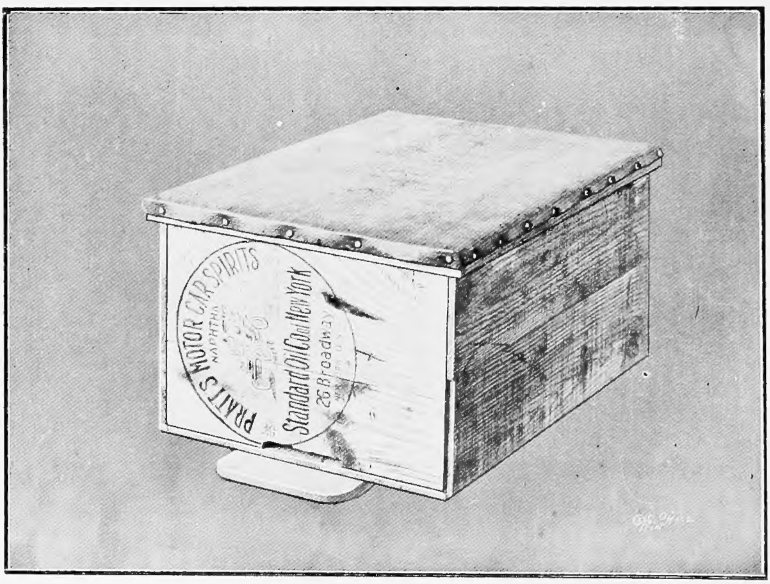
1909.



ISAAC HOPKINS, APICULTURIST.



Open, showing Frames.



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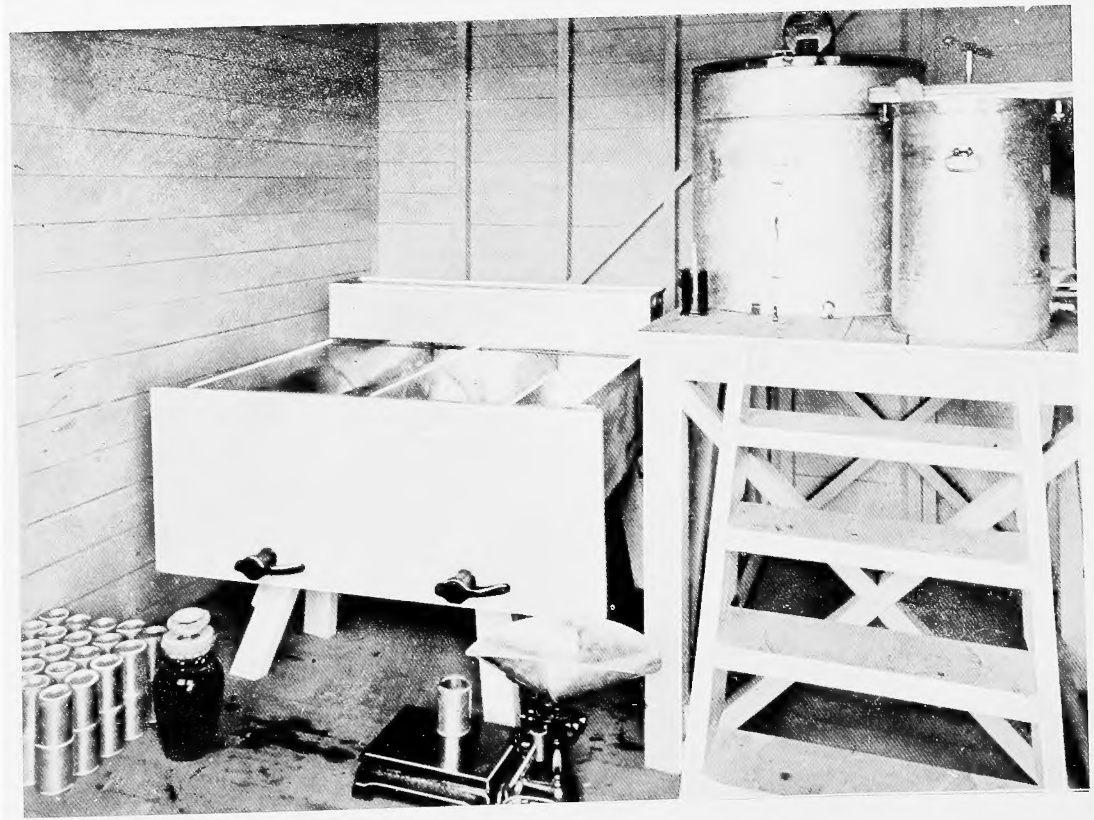

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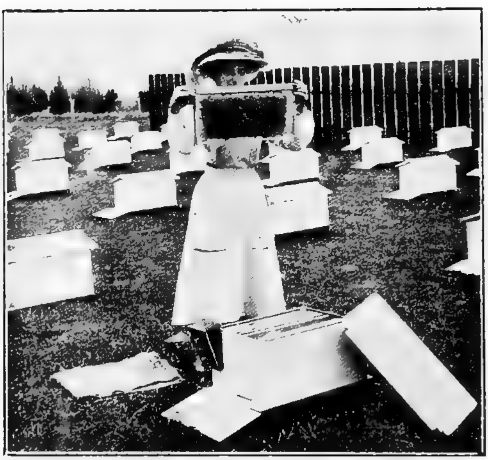

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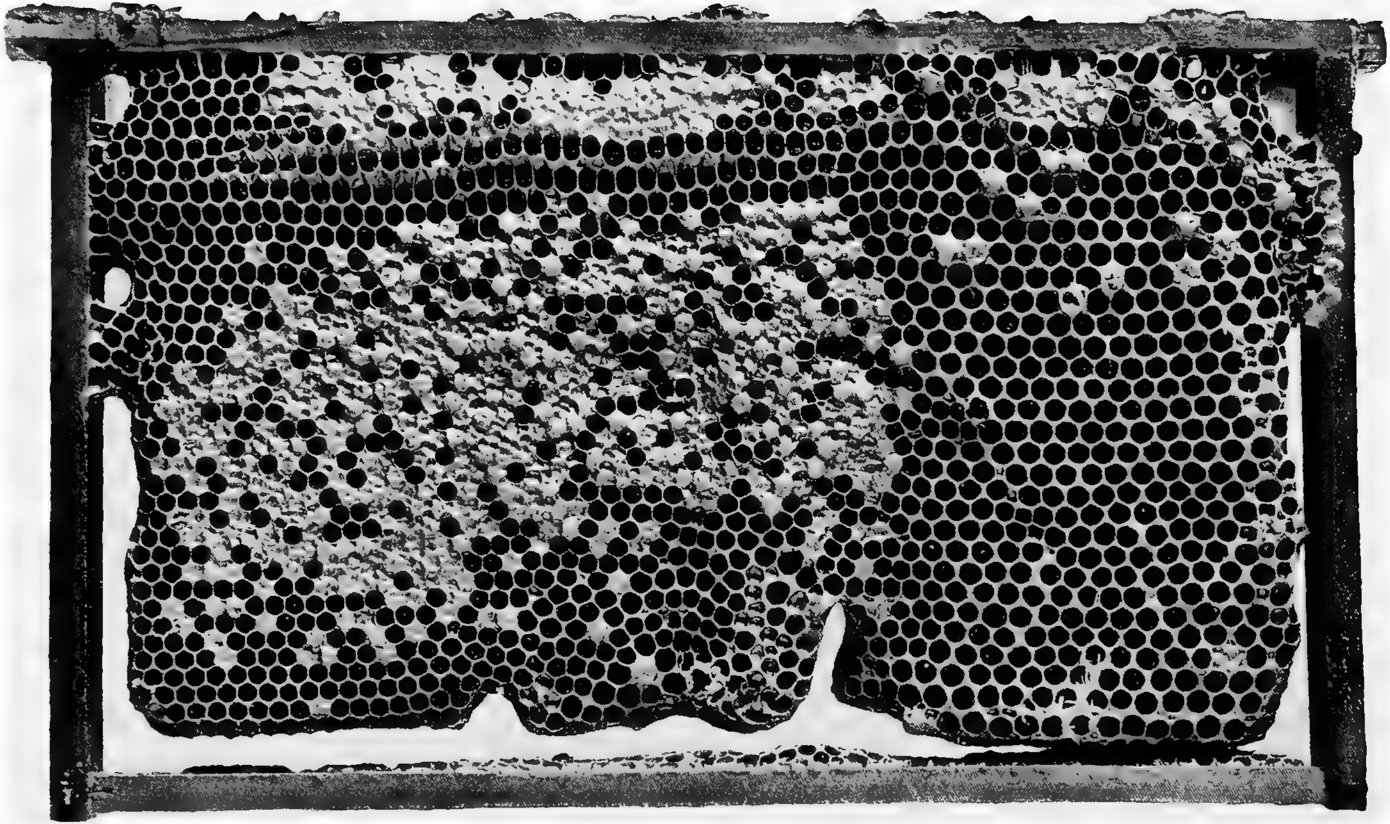

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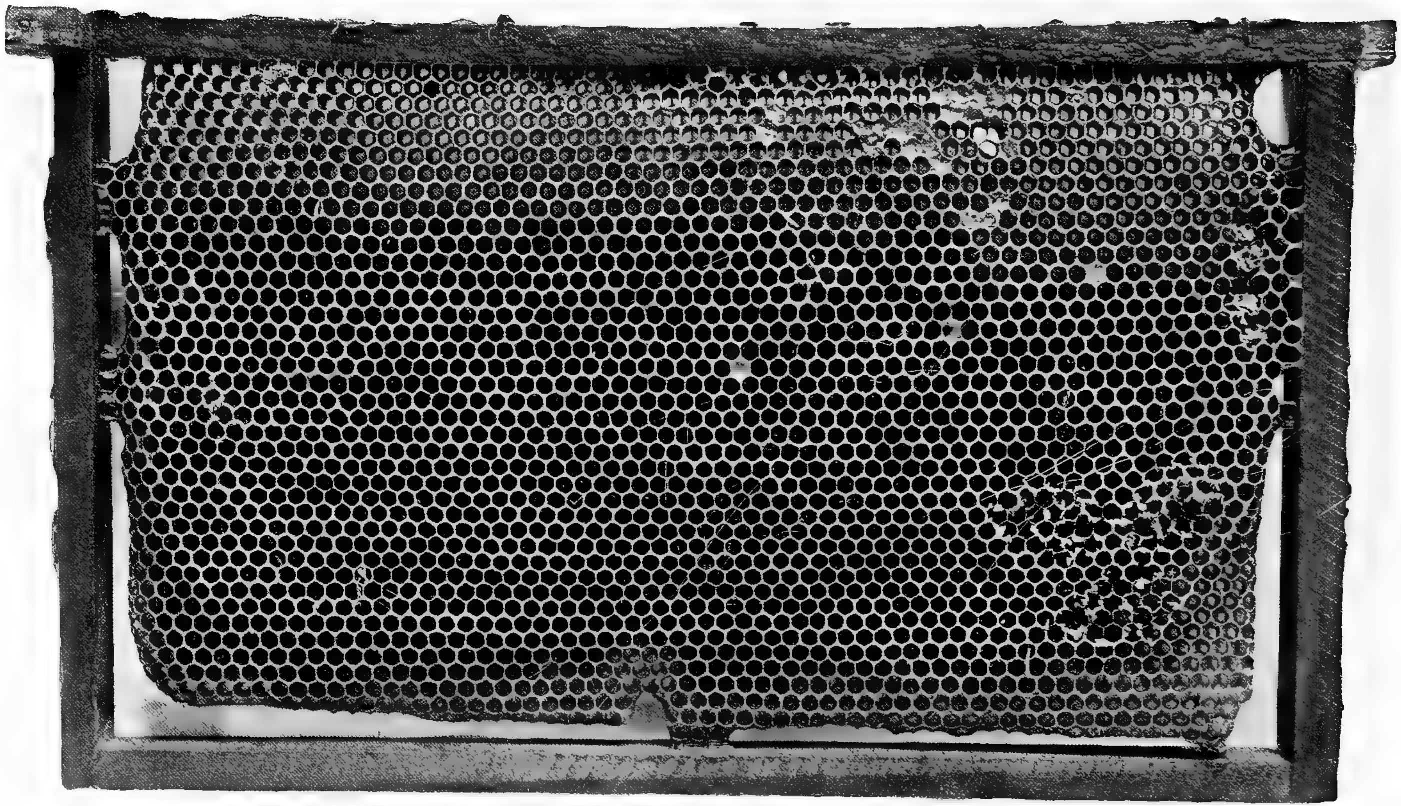
[See page 30.



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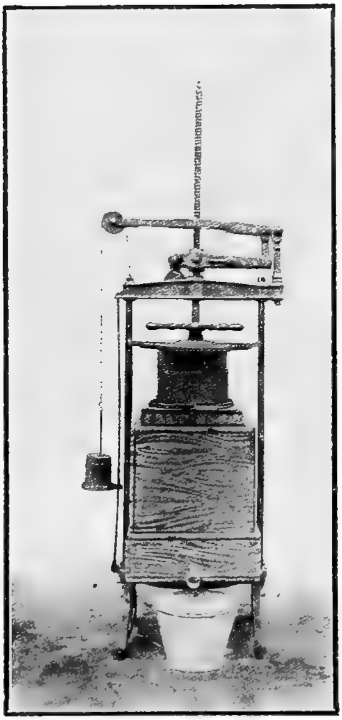
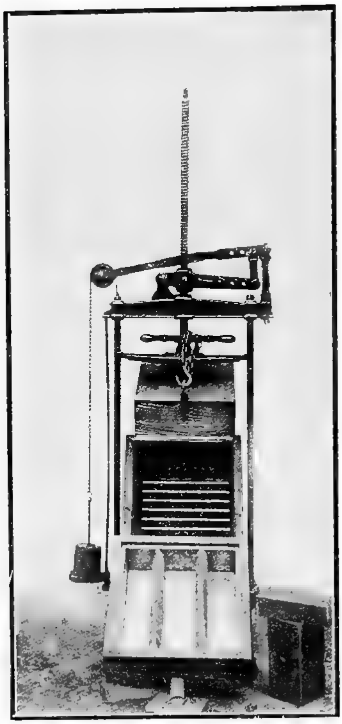


1. In Operation.



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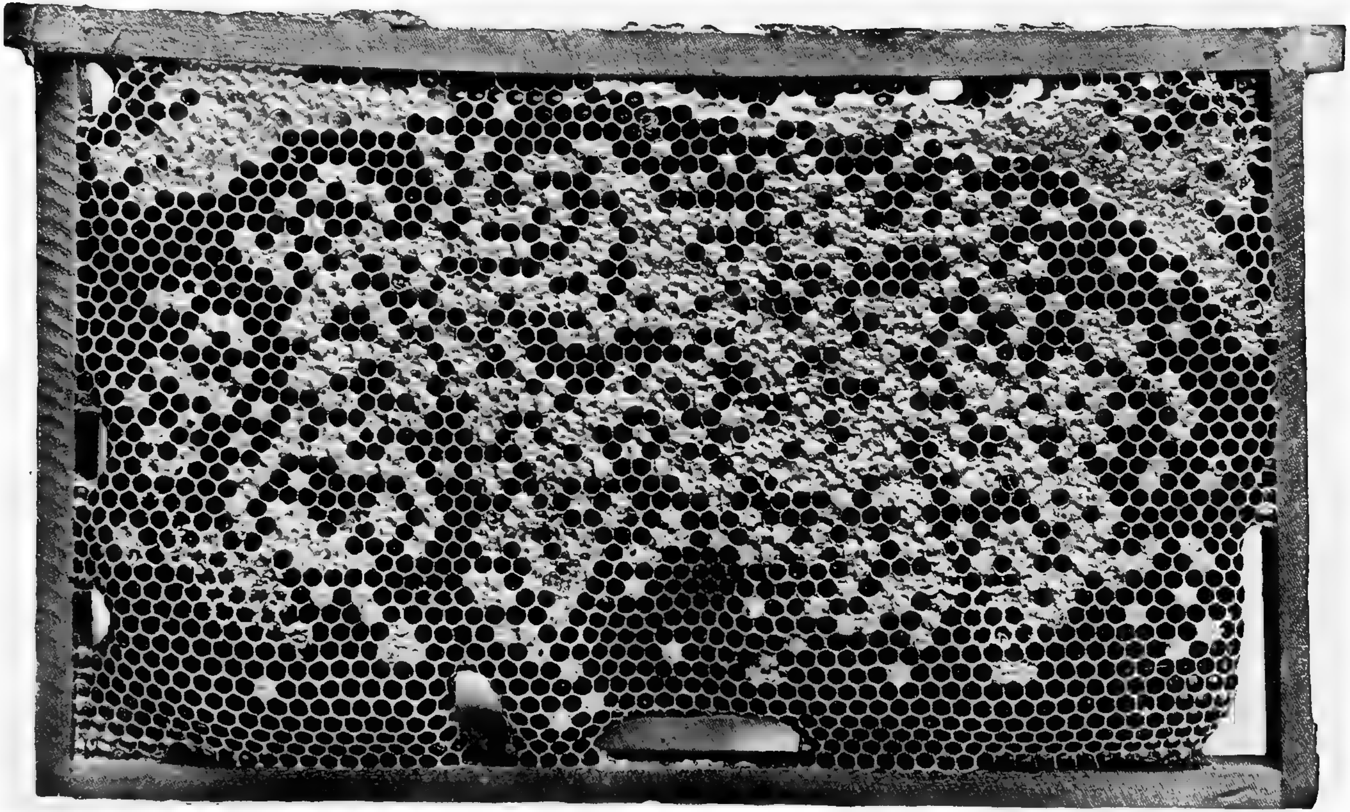

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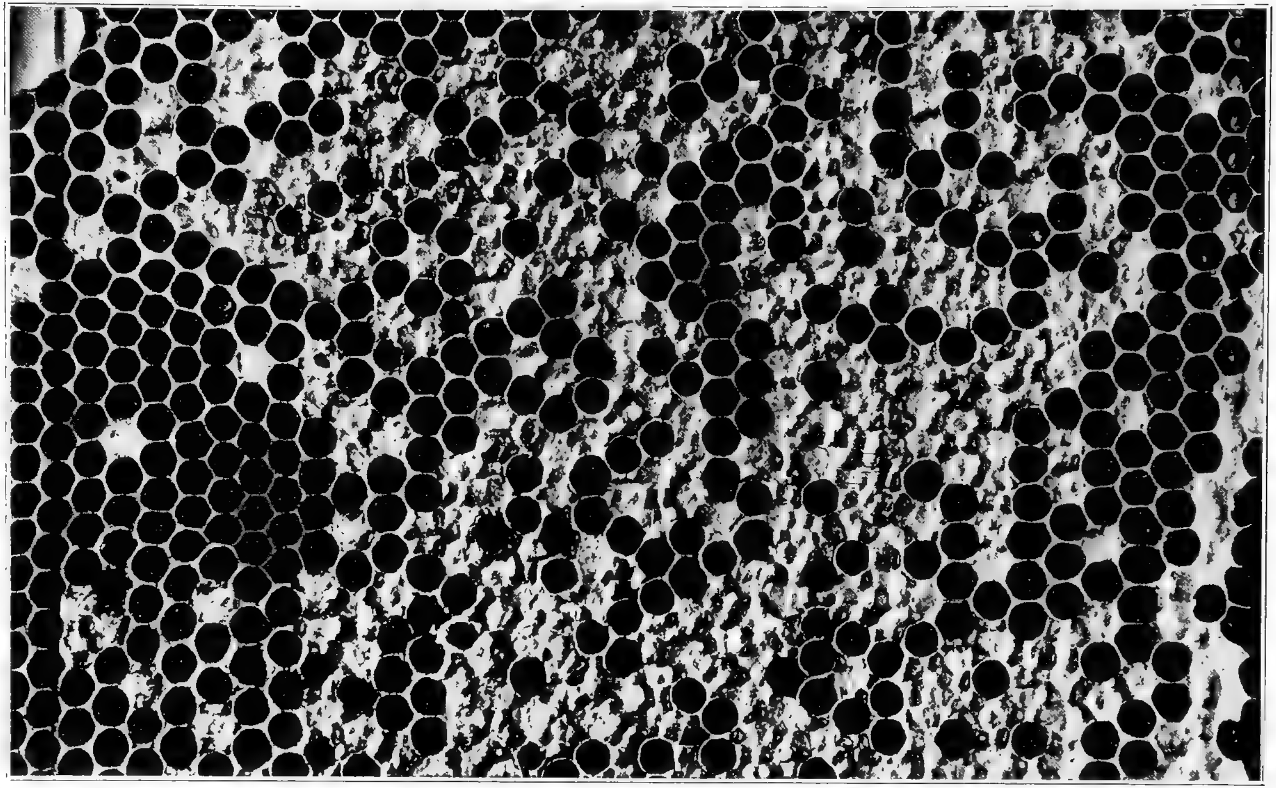

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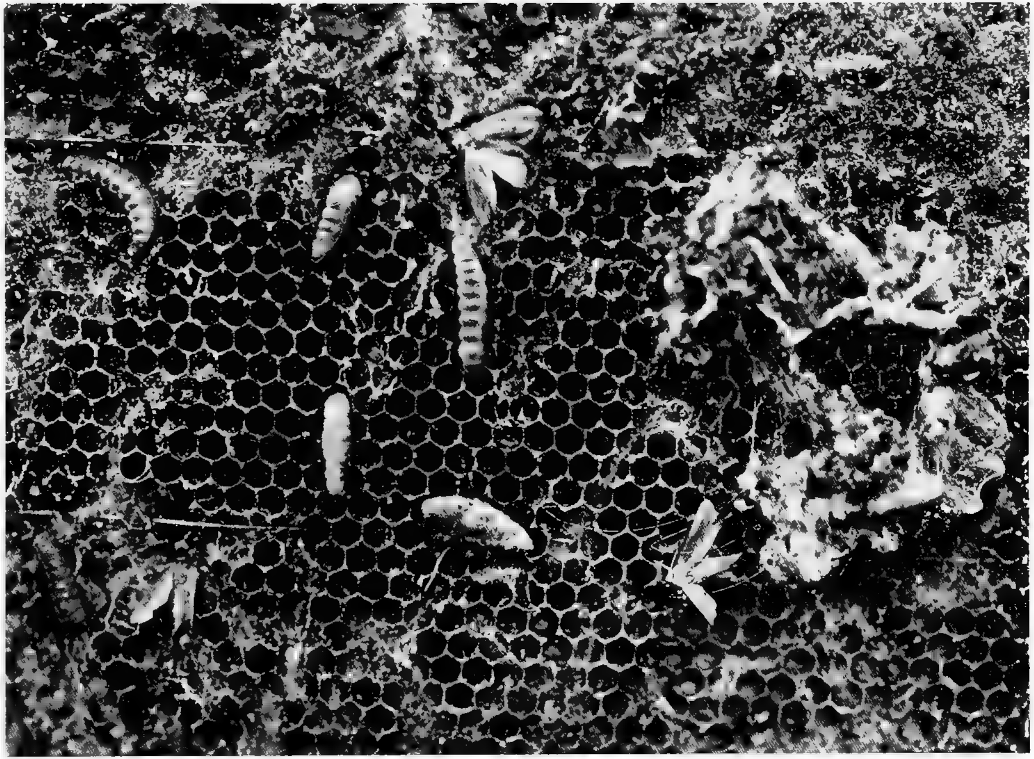

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(Third Edition, 25,000, March, 1909.)

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NOTE.

Department of Agriculture,
Division of Biology and Horticulture,
Wellington, N.Z., March, 1909.

THERE has been such great demand for Bulletins Nos. 5 and 18, both dealing with bee-culture, that the issues have become exhausted.

The two bulletins have accordingly been revised and added to, and brought into one complete bulletin, by the author, Mr. I. Hopkins, who this month retires from the public service.

The severance of Mr. Hopkins's connection with this Department will be deeply regretted, both by the beekeepers of the Dominion and by the officials. His connection with the Government service has given pleasure to all with whom he came in contact, and has proved highly beneficial to apiarists, the output of honey and wax having more than doubled in the last four years, largely through his efforts.

T. W. KIRK,
Chief of Division.

PREFACE.

The fact that within a period of less than four years two editions of this Bulletin, comprising 35,000 copies, have been exhausted, and a third one called for, is indicative in a marked degree of the exceptional interest taken of late in bee-culture in New Zealand.

The economic importance of commercial bee-farming is now universally recognised, and nowhere has this been more fully demonstrated than in the United States of America, where according to the latest official report (issued January, 1909), " There are in the United States 700,000 beekeepers, producing annually 20,000,000 dollars' worth of honey and 2,000,000 dollars' worth of beeswax." In British coin this means an aggregate value annually of nearly £4,500,000. Further, the report states that " The honey-bee probably does more good to American agriculture as a pollenizing agent than as a honey-producer."

The extraordinary progress made since the New Zealand Department of Agriculture considered bee-culture worthy of recognition has fully warranted the assistance it has received. Nothing has contributed more to this advancement than the passing of the Apiaries Act, which, for efficiency in dealing with foul-brood and the cause of its spreading, surpasses all similar Acts in existence at the present time. It has put new life into the industry, by encouraging the legitimate bee-farmer to look forward to the time when the chief source of his trouble hitherto, the common box hive, will have been swept out of existence.

The two former Bulletins, Nos. 5 and 18, have been revised, enlarged, and embodied in the present one. All subjects, including the chapter on Diseases and their Treatment, have been brought up to date, and the efficacy of the treatment prescribed has been fully proven in practice throughout the Dominion. The additional subject-matter will, I believe, further assist those who take up the fascinating occupation of beekeeping, whether for pleasure or profit.

I. HOPKINS,
Government Apiculturist.

Auckland, N.Z., March, 1909.

BEE-CULTURE.

PART I.—ADVICE TO BEGINNERS.

I. INTRODUCTORY.

THE advice given in this paper, though it chiefly concerns beginners who contemplate taking up bee-culture as a business, also applies to those who simply wish to keep a few hives of bees as a hobby and to work them successfully.

The term "bee-master" where used is intended to mean a skilled bee-keeper, and "bee-farmer" to indicate one who derives the whole or a large part of his income from his bees.

Any person may become a beekeeper, but to become a bee-master the aspirant must possess more than an ordinary share of patience and perseverance, and be prepared to give the subject of bee-culture his most careful study. He should be discerning and resourceful, have good judgment, with keen insight to anticipate, and be swift to take advantage of all circumstances likely to lead to success—in short, he should possess just such qualities as would contribute to his prosperity in any line of life. Procrastination is a serious imperfection under all circumstances, and especially so in bee-culture; bee-work cannot be put off without great loss, it must be done when needed, in fact it should be anticipated—a bee-master always keeps a little ahead of his bees.

It must be distinctly understood that successful bee-farming cannot be carried on without a good deal of work and close application, but, as the work to a bee-master is both interesting and congenial, it is never irksome. All bee-masters are enthusiasts in their calling, hence, in a great measure, their success. It may be said of those adapted for beekeeping, that once a beekeeper always a beekeeper, for there is undoubtedly, in spite of the stings, a charm about the work which, when once experienced, never loses its attractions.

Bee-culture is a rapidly progressive industry; new methods and appliances are constantly coming to the front, and things that are new to-day may be obsolete to-morrow; therefore it behoves the beekeeper to keep himself posted in everything going on in the beekeeping world through the excellent bee literature now at command.

WHO SHOULD NOT KEEP BEES.

All beginners suffer more or less from the effects of the bee-sting poison, but in most cases the bad effects wear off gradually as the system becomes inoculated against the poison, till, finally, little more inconvenience is felt from a sting than would be caused by the prick of a needle. In rare instances, however, people are to be found who suffer so severely that a sting is positively dangerous to them, their system never seems to become immune to the poison; it is scarcely necessary to say that such persons should not keep bees. Again, there are individuals too nervous to go among their bees without being clad in armour, as it were, from head to feet. I have known many such who had kept bees for a long time, and yet had never been able to get over their nervousness. In my opinion such people should not keep bees. No person who manages his bees properly can escape being stung occasionally, though I am sometimes told about individuals (I never come in personal contact with them) who can do anything with bees without being protected in any way, and never get stung. I have to listen, but never contradict a person who tells me this—it is suggestive, though.

BEEKEEPING FOR LADIES.

Bee-culture offers a splendid opportunity for our settlers' wives and daughters and other ladies who would like an outdoor, healthy, and profitable occupation. I may state that I take a special interest in this matter, and hope to be the means of inducing many of our young women to take up beekeeping as a business. As a result of the encouragement given to the industry by the Department of Agriculture, quite a number of ladies are doing so. Ladies who take to it make excellent apiarists—much better than the average man. In America they rank among the most successful beekeepers, and peasants' wives on the Continent of Europe usually look after the household bees, from which they derive a considerable proportion of the family income. There is nothing to prevent a fairly healthy young woman from managing and doing the work, with a little assistance during the height of the season, of an apiary of 100 hives. The work carried out by the lady apiarists at the Ruakura and Weraroa State Apiaries, where, in addition to their actual bee-work, they put together and paint the hives, make the frames, and do everything necessary on a bee-farm, affords practical proof that there is nothing connected with bee-farming but what a young woman can accomplish.

CADETSHIP.

Where it can be managed, the very best course for a young person intending to adopt beekeeping as a business is to go as a cadet for a season with some successful bee-farmer, beginning the season in September, when the bees are being prepared for the first of the honey-flow, and continuing till the honey has been prepared for market in the following autumn. Any young person with intelligence and application should be able to gain such a practical knowledge of the work as would enable him or her to start, confident of avoiding the mistakes usual in all new undertakings. I cannot speak too strongly of the value of such a course of training.

CADETS AT THE STATE APIARIES.

Suitable applicants of either sex, for a course of instruction in bee-culture, are received at the State apiaries each season as cadets, with the opportunity of gaining a certificate at the end of their term. They must conform to certain regulations, which may be learned on application to the Biologist, Department of Agriculture, Wellington.

The apiaries are open during working-hours to all persons desiring instruction.

PROFITS IN BEEKEEPING.

It is but reasonable that the prospective bee-farmer should want to know the probable profits attached to the business, consequently I am frequently asked the question. I realise that it is necessary to be very cautious in replying, and to guard against conveying a wrong impression, which might easily lead to disappointment and loss. All industries require the combination of three elements—capital, labour, and skill—and, although bee-farming cannot be carried on without the aid of the first two, it mainly depends upon the skill of the apiarist what the profits will be. It would be easy for me to show some surprising results that have been reached in New Zealand, but it would be dangerous to quote these as a measure of success or failure in all cases. As an estimate, however, I may state that from a well-conducted apiary, in an average good district, the net profits per colony of bees should reach from 17s. to £1 per annum through a number of successive seasons, and this estimate I consider well within the mark.

It is a rule, without exception, in beekeeping that with largely increased operations, and the establishment of out-apiaries, the average profit per hive diminishes, though the aggregate profits may be very much larger. No doubt this may be accounted for by the inability of the apiarist to give each individual colony so large a share of attention.

BEEKEEPING COMBINED WITH OTHER PURSUITS.

The old adage which warns us against putting all our eggs into one basket is especially applicable to beekeeping. I always recommend, when asked, the combining of some other occupation with bee-culture for the first few years, so that there may be another source of income in the event of a bad season for honey. A person, having made up his mind to adopt bee-farming as a business, if a beginner, should begin in a small way, and, while at his usual occupation, work up an apiary large enough to warrant his devoting a good part of his time to it. This, in all probability, will take at least three or four seasons, and in that time he should have become fairly proficient if his heart is in the work—if not, he had better give it up.

Fruit-growing and poultry-farming work well with beekeeping, but it must be distinctly understood that the bees, to be profitable, must have first attention—that is to say, if neglected for other work when they need attention, the bees will prove nothing but a loss to the owner. I am frequently asked about dairying and bee-farming; I cannot recommend this combination unless the dairying is on a very small scale indeed, for I think the wearing life of a dairyman is against his being able to pay close attention to anything else.

BEEKEEPING LITERATURE:

Beekeepers are well catered for in respect of literature. There are a number of excellent standard works, but unfortunately they are all but one published in the Northern Hemisphere, and deal with opposite seasons and different conditions to those which obtain here. "The Australasian Bee Manual" is written and published in New Zealand, and coincides with our seasons and flora. The periodicals devoted to bee-culture are also excellent, so that a beekeeper who falls behind the times with so much good literature within his reach has only himself to blame. Every beginner should not only secure and read up one or more standard works, but he should also subscribe to at least one good periodical. I shall enumerate some of the best works and periodicals, and give their approximate prices in New Zealand. Any of them may be obtained through booksellers, or from those firms who cater for beekeepers.

Standard Handbooks.

	s.	d.
"The A B C and X Y Z of Bee-culture"	6	0
"Langstroth on the Honey-bee." Revised	7	0
"Cook's Manual of the Apiary"	6	0
"Advanced Bee-culture"	6	0
The above are American.		
"British Beekeeper's Guide-book" (English), paper covers, 2s.; cloth	4	0
"The Australasian Bee Manual," by Isaac Hopkins (2s. 9d. by post)	2	6

PERIODICALS.

			s.	d.
Gleanings in Bee-culture. Fortnightly	.. ..	Per annum	6	0
American Bee Journal. Monthly	.. ..	,,	5	0
Beekeeper's Review. Monthly	.. .. ..	,,	6	0
Canadian Bee Journal. Monthly	.. ..	,,	6	0
British Bee Journal. Weekly	.. .. ..	,,	8	0
Australasian Beekeeper. Monthly	.. ..	,,	5	6
Australian Bee Bulletin. Monthly	.. ..	,,	5	6

Various New Zealand journals contain articles on bee-culture.

Outlay for good bee literature should never be stinted, for the obtaining of one good "wrinkle" from the experience of a writer may be the means of adding largely to the profits of an apiary.

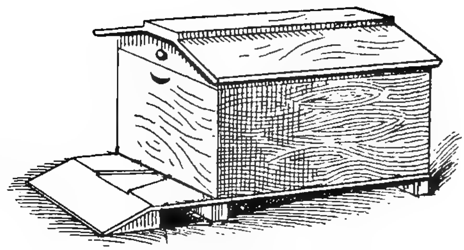
II. THE HIVE TO ADOPT.

Happily the time is past, in New Zealand at all events, when the keeping of bees in common boxes, with the accompanying system of sulphuring them at the end of the season for the little honey obtainable, was allowed. It was a most wasteful method, to say nothing about the danger of propagating and spreading bee-diseases and the painful suggestion of cruelty.

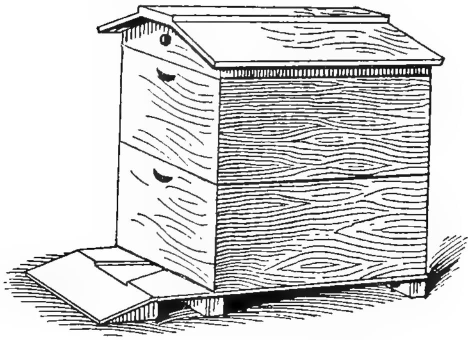
THE LANGSTROTH HIVE.

In giving advice on this matter, and selecting a particular hive for recommendation, I do so for two distinct reasons—first, beause I believe the hive to be the best of those now in use (though I am aware that other patterns are advocated by a few beekeepers); and, secondly, because it is in general use in every part of New Zealand—the Langstroth hive. The latter reason alone should be a very important one to beginners, as it enables the manufacturers to supply them cheaper, on account of having to keep one kind only in stock, and, being of one standard pattern, they are exchangeable and saleable all over the Dominion.

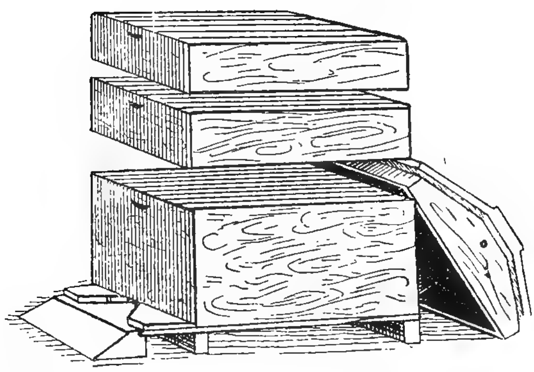
I had the great pleasure of introducing the Langstroth hive into Australasia in the season of 1877–78, and it has practically been the standard for these colonies ever since; naturally, therefore, I recommend it here (see Figs. of Langstroth hives, next page).



Langstroth Hive, Single Story.



Langstroth Hive, Two Stories.



Langstroth Hive, with Two Half-stories for raising Section-honey.

In 1851 the Rev. L. L. Langstroth perfected the hive which now bears his name, and gave it to the world. It is astonishing when we realise how perfect it must have been when it left his hands, for, notwithstanding the many attempts made since to improve upon it, the Langstroth hive remains to-day not only the same, but the foremost in use and popularity among the most experienced apiarists in the world. We rarely hear at the present time of such hives as the Quinby, Adair, American, and

Gallup, yet these were favoured largely in America at various times; they have gone, and the Langstroth remains. Even the famous G. M. Doolittle, the great American authority on bee-culture and the erstwhile champion of the Gallup hive and frame, has come round to the Langstroth. I have before me an extract from a letter received recently by an Auckland resident from Mr. Doolittle in reply to one sent him asking his opinion as to the best hive. He says,—

> I do not now use the hive I described in my little book "The Hive I use" to the extent I did, as I find the Langstroth hive does nearly as well with less labour, and we have only the 1 lb. sections now, the larger ($2\frac{1}{4}$ lb.) not finding a ready sale. I judge the Langstroth hive is as good as any for New Zealand.

It is evident that Mr. Doolittle feels a pang in giving up his old love, and though he reluctantly does so, he admits the Langstroth is the best hive. It is gratifying to me when I remember how persistently I have advocated in the past this hive against all comers.

It is the misfortune of many beginners to believe, before they even understand properly the rudiments of bee-culture, that they can improve upon the Langstroth hive, and then and there start out to modify it in some shape or form, only to regret it when experience has convinced them of their mistake and loss. I have nothing to say against an experienced beekeeper experimenting in any direction in which he may consider an improvement possible—in fact, he should be commended for doing so—but having seen so many mistakes made by beginners I feel it my duty to warn others against falling into the same errors.

MAKING HIVES.

There is no reason why a person handy with tools, and with spare time on his hands, should not make his own hives, but it must be understood that they should be made very accurately. On the other hand, a person may find it to his advantage to purchase all he requires from the manufacturers. In the former case one at least should be purchased, in order to have an accurate pattern to work from. The internal fittings, such as frames and sections, should certainly be procured from the manufacturers, as it is well-nigh impossible to make these accurate enough without machinery.

A very good plan when more than one hive is wanted is to get one made up, and the rest in the flat, in parts ready to be nailed together, and so save in cost of carriage.

A CHEAP LANGSTROTH FRAME-HIVE.

(See Plate II.)

Though there may not be much gained in the long-run by making any other than good substantial hives in the first place, especially by those who

can construct their own, there may be settlers to whom the question of saving a shilling or two upon each hive is a consideration. In such cases the following directions for converting a kerosene-case into a Langstroth-frame hive of the same dimensions as the standard Langstroth, and which complies with the Apiaries Act, should be of service :—

Secure a complete and sound kerosene-case, and carefully knock off one of the broad sides ; nail on the original cover, which will now form one of the sides. If the sides of the case are not level all round, build them up level with fillets of wood. The inside depth should be 10 in. Next nail on at each end, half an inch below the inside upper edges of the case, to suspend the frames from, a fillet of wood $\frac{3}{8}$ in. thick by $\frac{3}{4}$ in. wide, and the length of the inside end of the case. The frames when suspended from these should be a clear $\frac{3}{8}$ in. off the bottom of the hive. An entrance $\frac{3}{8}$ in. wide by 6 in. long should be cut out of the lower part of one end of the case, and a small alighting-board be nailed on underneath, projecting from 2 in. to 3 in. in front. (See Plate II.) A loose bottom board can be arranged if thought desirable.

Top or surplus honey-boxes can be made in the same way, but will not require a bottom.

With regard to comb-foundation, see Part II, Chapter I.

I strongly recommend the purchasing of " Hoffman self-spacing frames " from the manufacturers, as they need to be very accurately made, and are difficult to make by hand. If, however, it is desired to construct frames it is not so difficult to make loose-hanging ones ; the following are the dimensions :—

Cut the top bar $\frac{15}{16}$ in. wide by $\frac{3}{4}$ in. deep, and $18\frac{3}{4}$ in. long. Shoulders should be cut out on ends $\frac{7}{8}$ in. long, leaving a thickness of $\frac{1}{4}$ in. to rest on the fillets. The ends should be $8\frac{1}{2}$ in. long, the same width as the top bar, and $\frac{3}{8}$ in. thick ; bottom bar $17\frac{1}{2}$ in. long, $\frac{3}{4}$ in. wide, and $\frac{1}{4}$ in. thick. There are ten frames to each hive.

The cover can be made from the side knocked off, and should have small fillets, 1 in. wide, nailed on right round the edge, to overlap the body. Cover the top with ruberoid or other waterproof material, and let it overlap the edges. (See Plate II.) A capital waterproof covering can be made by first giving the wood a good coat of thick paint, and, while wet, laying on open cheese-cloth (not butter-cloth), letting it overlap the edges, and painting over it. The paint on the wood will ooze through the cloth, and the covering will last for years—no tacks are needed. Light-coloured paint is best, as with this the hive will keep cooler when exposed to the sun than if painted a dark colour.

The actual outlay for such a hive, allowing 4d. for the box, would be under 1s., providing the person makes his own frames.

There are a large number of these hives in use at the present time.

When setting the hives out, keep them raised five or six inches off the ground on bricks at each corner, so that there may be good ventilation underneath.

III. WHEN AND HOW TO START BEEKEEPING.

The best time for a beginner to start is in spring or early summer; he should never commence in the autumn, except under the guidance of a practical man. The outlay in the first instance should not exceed what is required to make a small beginning. The only exception would be where a season had been previously served as a cadet. "Go slow" should be a maxim for all beginners. I have known of many disappointments and losses through acting contrary to this advice. The hives should be on hand in the early spring, and arrangements should have been made with some neighbouring beekeeper for a couple of early swarms, which should not weigh less than 5 lb. each. There are approximately five thousand bees to the pound, so that a 5 lb. swarm contains about twenty-five thousand bees. To ascertain the weight of the swarm, a swarm-box should be supplied by the purchaser in which to put the bees; weigh the box before using, and again when the bees are in it; deduct weight of box from the full weight, and the difference will be the weight of bees.

A swarm of 5 lb. and over is practically certain to have a laying queen at its head, as a second or after-swarm with a virgin queen weighs much less. Go to a reliable bee-farmer, if possible, and arrange for swarms; a good swarm is presumably free from disease, otherwise the colony could not have thrown it off. Take the advice of the person you arrange with, and let him bring and hive the swarms for you, if possible, as it will give you a lesson in handling bees If preferred, a start can be made with established colonies at an increased cost.

START WITH COMMON BEES.

Common bees being the least expensive it is advisable to start with them. Do not go to the extra expense of purchasing Italians till you have made some headway and gained experience; then Italianise your apiary on economical lines by buying queens only from some reliable queen-breeder.

THE HONEY TO RAISE.

We have different grades of honey in New Zealand, most of it of a superior quality; but undoubtedly the best from a consumer's point of view, and for marketing purposes, is that gathered from white clover. Much of our bush honey is very fine, and preferred by some for its stronger flavour, but what the bee-farmer must consider is, which is the most saleable and profitable to produce. The answer to that unquestionably is, "Clover honey." It is true that the output of an apiary in a purely clover district is likely to

fall below that of one in a mixed flora or bush district, but the difference in quantity will be more than made up by the better price obtained. At present the largest demand is for the best grades of table-honey, both for our local markets and for export. We have little or no demand for the poorer grades that would answer for manufacturing purposes, and the latter would not pay for exporting, as Europe can be supplied much cheaper with that class of honey from the West Indies and South America. I therefore recommend the raising of white-clover honey for commercial purposes as being the most profitable. A little admixture of dandelion honey improves the flavour and appearance of clover honey.

RAISING SECTION-HONEY.

The foregoing paragraph refers particularly to commercial bee-farming and the production of extracted honey, but the beginner will do well to raise comb-honey in 1 lb.-section boxes at the start, and so avoid the necessity of purchasing an extractor and other appliances. All the standard works already mentioned contain instructions for working for each kind of honey.

COST OF A BEGINNER'S OUTFIT.

The following is a list of appliances necessary to make a good start, with the manufacturer's prices for same. If the hives are made at home the total cost will be very much less, and the expenses of freight and carriage saved :—

	£	s.	d.
One hive with two half-stories for raising comb-honey, made up and painted (as on page 14)	1	5	0
One case of 3 ditto in flat	2	10	6
6 lb. of medium brood foundation comb	0	15	0
2 lb. thin section foundation comb	0	6	0
One bee-smoker	0	4	6
One bee-veil	0	2	0
	£5	3	0

IV. THE APIARY.

CHOICE OF A LOCALITY FOR BEE-FARMING.

This is one of the most important matters to come under the consideration of the prospective bee-farmer, and requires careful judgment. A hasty decision may cause great disappointment and loss, for, once having established an apiary, it is troublesome and expensive to move it. Having decided that white-clover honey is the most profitable to raise, it is imperative that the apiary should be established in a clover country. There can

be no doubt that dairying districts afford the best clover pasturage, so far as bee-farming is concerned. The pasturage in sheep country is, as a rule, kept pretty closely cropped, and the clover has very little chance to blossom when heavily stocked. Country where much successive cropping is carried on is useless for bee-farming, so that one cannot do better than fix upon some dairying district.

The prospective bee-farmer in New Zealand is exceptionally fortunate in having so large an extent of country to choose from, over which the very finest honey can be raised. It is doubtful, taking area for area, whether the Dominion can be excelled in this respect by any country where commercial beekeeping is carried on. Starting from Auckland, we have clover country over the whole of the Waikato, Thames Valley, the east and west coasts, Wairarapa, and central parts of the North Island; and in the South Island clover country abounds over a large part of the Canterbury Province, and a good deal is found in Otago and Southland, and also in the Nelson and Marlborough districts, so that there is ample scope for the bee-farmer, and he need not be restricted to any part of the Dominion in making a choice; but I strongly advise every person seeking a place for the purpose to visit two or three of the districts mentioned before finally deciding. Though the honey raised in the Taranaki Province is first-class, and better than can be secured in many other parts of the Dominion, I cannot recommend the coastal districts as suitable for commercial bee-farming, as the boisterous weather that prevails in the spring, and the salt spray blown over the land occasionally, would militate against success. The inland districts, away from these influences, will no doubt prove much more favourable.

The country north of Auckland will as dairying increases be more suitable for bee-farming than it is at present. Most of the honey raised there, though very good and very suitable for manufacturing purposes, cannot be considered first-class table honey, such as is in the greatest demand.

SITE AND SHELTER.

Slightly undulating country is much better than a flat open site for a bee-farm. The natural shelter obtained in the former is a great advantage, as it affords the bees protection in some direction or other, in almost all weathers, when on their foraging expeditions. In any case, the apiary should be well sheltered, and in the absence of shelter of some kind it should be erected at the start. A depression in the ground will assist, and a temporary fence 6 ft. high of boards, or of tea-tree brushwood, on the windy sides (see illustrations of State apiaries) will do while shelter-trees or a live fence are growing.

I cannot speak too favourably of the advantages derivable from a properly sheltered apiary. The bees thrive as well again as they do in an

exposed one, the losses are smaller, the apiarist can work his bees in almost all weathers, and in greater comfort.

High trees near an apiary are sometimes objectionable, as they afford an opportunity for swarms to settle away high out of reach.

For a rapid-growing shelter-hedge giant privet and tagasaste (commonly called "tree-lucerne") are to be recommended, where cattle cannot get within reach of them. Tagasaste (see Plate III) affords splendid bee-forage, as well as shelter, and it grows very rapidly; but it can only be considered suitable for a temporary hedge, as it is likely to become a prey to the borer. The tagasaste hedge at the Waerenga Experimental Farm, shown in the plate, was but four years old when it was killed by the borer. Still, it is worth planting at the same time as the more permanent hedge-plants are put in, as it affords shelter very rapidly and abundance of bee-forage at times when it is most valuable.

If a double hedge of tagasaste and giant privet is planted the rows should be 6 ft. apart. In any case plant plenty of tagasaste in waste places for bee-forage; the plants last longer when left untouched by shears.

The following cultural directions and general particulars respecting these two plants for shelter-hedges for apiaries are by Mr. J. E. Barrett, lately nurseryman at the Government Experimental Farm, Waerenga, Waikato:—

Tagasaste (*Cytisus proliferus*).

This plant is often erroneously called "tree-lucerne," the botanical name of which is *Medicago arborea.* They both belong to the same family, (Leguminosæ), but to different tribes, that of Genisteæ claiming the tagasaste, and Trifolieæ the medicago or true tree-lucerne. Of the quick-growing and sheltering qualities of the tagasaste we have had several years' experience at Waerenga. In the month of February, 1903, a row 3 chains in length was sown in the nursery on stiff clay land, and in two years from sowing a dense and picturesque screen nearly 10 ft. in height was formed. At Waerenga this plant continues growing the whole year through, and, excepting a break of about two months in the autumn, is equally free in the production of its white pea-like blossoms, upon which the bees may be seen constantly at work. The latter fact renders this plant of special value to beekeepers during the months when other flowers are scarce.

To obtain the best results the seed should be sown in early spring, and to assist germination it should be first steeped in very hot water (not boiling) to which a little washing-soda is added—pouring on the water and letting it stand till quite cold will suffice to soften the seed, and, after straining, the addition of a little dry sand will separate it nicely for sowing. It is important that seeds treated in this manner should be sown immediately.

The ground should be thoroughly worked (as for onions), and if, as is to be recommended, a double row is contemplated, the width of the prepared bed should be not less than 4 ft. Sow the seeds three in a place at a distance of 3 ft. apart and 1 ft. from edge of bed on either side, alternating the second row with the first—this gives a distance of 2 ft. between the rows. Thin out the plants as they advance, to the strongest in each place.

Giant-growing Privet (*Ligustrum sinense*).

For permanency and general utility this plant can be thoroughly recommended as a shelter-hedge. It is of close upright growth, extremely hardy, and adapts itself well to a wide variety of soils and situations. It is not advisable, however, to employ any of the Ligustrum as hedge-plants too near a garden plot, as their surface roots extend several yards from the base on either side, and extract all virtue from the soil. This fault can be obviated to a great extent by cutting ditches at a little distance from the plants on either side. Assuming that this space is of no consequence, then the privet may be advantageously employed for shelter purposes. For a single row a width of 3 ft. should be deeply dug, and if the ground be poor a liberal dressing of bonedust given. Select strong two- or three-year-old plants, and set out at 18 in. apart along the centre of the prepared ground. To induce a good base it is well to clip the plants fairly hard back at the time of planting; in following seasons the sides may be lightly clipped, and the tops of those unduly high reduced to a general level. With fair treatment four seasons of growth should produce a hedge from 6 ft. to 8 ft. high. As there are many different species of Ligustrum in cultivation, care should be taken to get the best for hedges—that is, the one under notice.

Where the surrounding country is hilly, the apiary should be situated in the lowest part, if possible, so long as it is not swampy or wet, in order that the bees when coming home loaded will have to fly down instead of upward.

All large apiaries should be established a good distance from a public thoroughfare, especially from a main road where there is horse traffic; otherwise there are pretty certain to be complaints sooner or later, and everything should be done to avoid giving offence. From 100 to 200 yards from a main road should be ample, but much depends on the locality, and the safe distance can be best judged on the spot.

WATER.

Bees require a great deal of water during the breeding season, therefore a small running stream near at hand is a boon; otherwise water should be provided in troughs, with floats, or filled with pebbles, placed in some shady spot near at hand.

Unless there is a continual supply of water near at hand the bees are apt to become a nuisance to neighbours in their search for water by crowding round horse and cattle troughs, the domestic tanks, and other inconvenient places.

AREA OF GROUND FOR A BEE-FARM.

Half an acre will afford ample space for a good-sized apiary and the necessary buildings; but if renting a site, as many do, it would be as well to rent an acre, so as not to be cramped for room in case of extending operations. A good substantial cattle-proof fence around the site is absolutely necessary.

LAYING OUT AN APIARY.

The site for the hives should be as level as possible, for convenience of taking appliances and combs to and fro. It should be laid down in grass, and be kept closely cut, especially near the hives. The best arrangement of the hives in every respect is in straight rows, with entrances facing the north or north-east—never face them westward if it can possibly be avoided. (See Plate V, model apiary, Ruakura Experimental Farm.) Occasionally there is a departure from this form of arrangement, some preferring to place their hives in clusters of three or more, with their entrances in different directions. I certainly do not approve of the latter method, as it appears to me to be very inconvenient in several ways without any compensating advantages. A glance at the extensive American apiaries illustrated in the "A B C of Bee-culture" should convince one that the straight-row system is adopted by the majority of bee-farmers in that country.

A serious mistake is often made in placing hives too close together, as is shown in Plate IV, "An Overcrowded Apiary." Fighting and robbing among the bees is much more likely to take place under such conditions than when the hives are a suitable distance apart. They should be at least 6 ft. apart in the rows, and the rows 8 ft. apart. In the Ruakura State Apiary I have placed them 8 ft. apart from centre to centre in the rows, and the rows 10 ft. from centre to centre, with the hives in each row opposite the spaces in the rows in front and behind. There is thus ample space to work at any hive without standing in the line of flight to or from any other hive, and a lawn-mower or scythe can be used anywhere about the apiary. The main portion of the Waerenga queen-rearing apiary is laid out in the same manner (see Plate VA), but the nucleus hives (Plate VB) are dotted about irregularly, so that young queens can better locate their own when returning from flying out.

KEEPING THE HIVES FREE FROM GRASS.

Long grass and weeds immediately around the hives not only look unsightly, but also form shelter for insects which find their way into them in cold weather. Woodlice are disgusting insects which may often be found in neglected hives by thousands in winter; but by keeping the hives clear of all growth neither these nor other insects will be troublesome.

One of the readiest and cheapest methods for accomplishing this is to cut a small shallow trench around each hive, 9 in. distant from it, and strew salt over the ground within the trench. This kills the grass and weeds. A good plan is to use a piece of 9 in. board for a guide for cutting the trench. At the State apiaries it was found that 6 lb. of salt was sufficient for each

hive, and this was effective for over six months, and by occasionally keeping the ground stirred it lasted much longer. The cost was less than 2d. per hive—using the cheap agricultural salt. All the hives at the State apiaries are now treated in this manner.

SHADE.

Many amateur beekeepers imagine that hives containing bees need shading, and forthwith place them under trees in dense shade. No greater mistake could be made in bee-culture. Bees love sunshine, and, if in the hives recommended, they should be in the open where they can get all the benefit of the sun, summer and winter. Though the shade of fruit-trees—being deciduous—might not be objectionable, there is no need of it. The hives, if painted white, or a light colour, and the ventilation from the entrances properly attended to, are better out free from all obstruction to rapid work. After bees have been located in dense shade for a while they become very vicious and difficult to handle, and in continuous wet weather, and also during the winter, the inside of the hives becomes damp, and the combs mouldy, which is injurious to bees. Bees themselves indicate when the ventilation is insufficient. When they are seen near the entrance with heads down and their wings vibrating—understood as "fanning"— they need more ventilation, and it should be given by enlarging the entrances.

FLAT COVERS.

I consider these an abomination, and they should not be tolerated in any apiary. They twist and warp, require "shade-boards" over them, and lumps of rock to keep the shade-boards from blowing off, and altogether form the most unsightly and inconvenient fit-out as covers it is possible to imagine. An apiary that otherwise would have a picturesque appearance is transformed into an ugly bee-yard by such covers. Independent of their appearance, flat covers prevent such a free circulation of air as is obtained under the gable covers as shown in the illustration of the State Apiary. Although a flat cover is shown on the kerosene-case hive, it will be quite understood that this is an exceptional circumstance in which the cheapest form of frame-hive is represented.

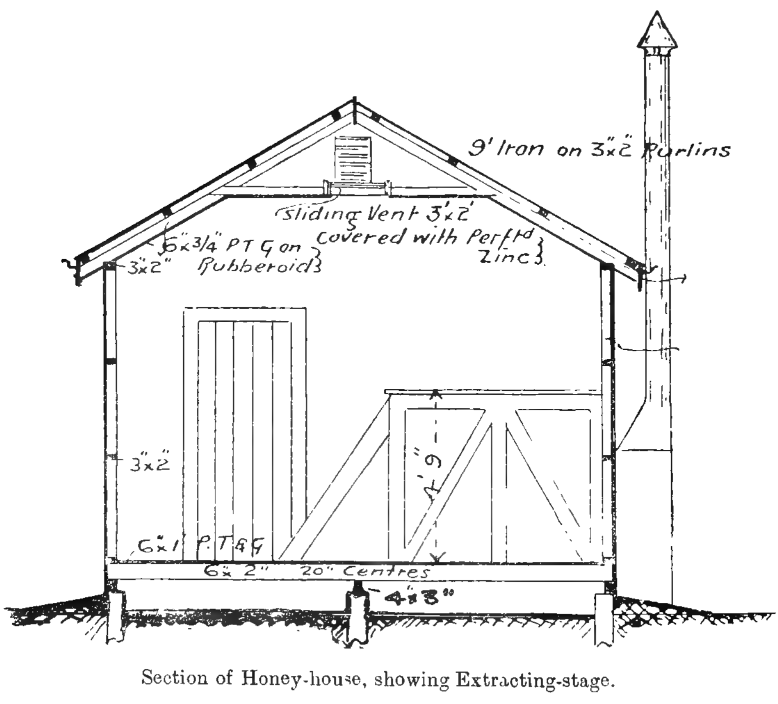
A very great advantage in connection with the gable cover, with ventilating-holes at each end, is that the air in the space above the frames can never rise in temperature above that of the surrounding atmosphere. Directly there is a tendency in this direction, the warm air expands and rushes out of the ventilating-holes, and the cooler air takes its place, thus keeping the internal part of the hive much cooler than is possible with a flat cover. Whether flat covers are adopted on economical grounds I do not know, but I am surprised at any one using them, for if the gable covers cost four times as much I would have them in preference to the flat ones.

APIARY BUILDINGS.

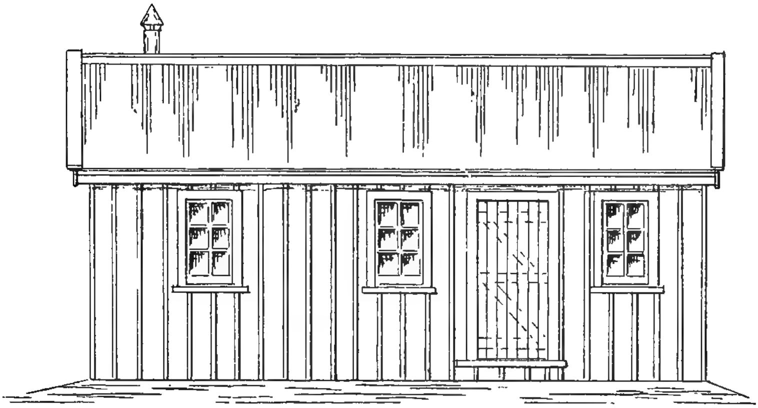
An extracting-house (Plate VI), fumigating-room (Plate VII), honey-room, and workshop or store-room are absolutely necessary in a properly equipped apiary. They can be all under one roof or in one building, and need not be very extensive, but should provide ample room for doing all the work of extracting, tinning the honey, fumigating combs, and storing spare hives and combs during the winter. I have been surprised when on my rounds to see the cramped, makeshift places at many apiaries doing duty for extracting-house, store-room, &c. If carrying on any other business than bee-farming, I expect the selfsame people would think it necessary to provide themselves with a suitable building, but they do not seem to realise the inconvenience and loss they sustain through not having suitable accommodation for carrying on their work. It will pay all bee-farmers to carry out their work on proper lines.

I do not expect all extracting-houses will be built on the same plans as are herein given. The contour of the ground may make it convenient to adopt some modification, but the plans show in a general way what is needed.

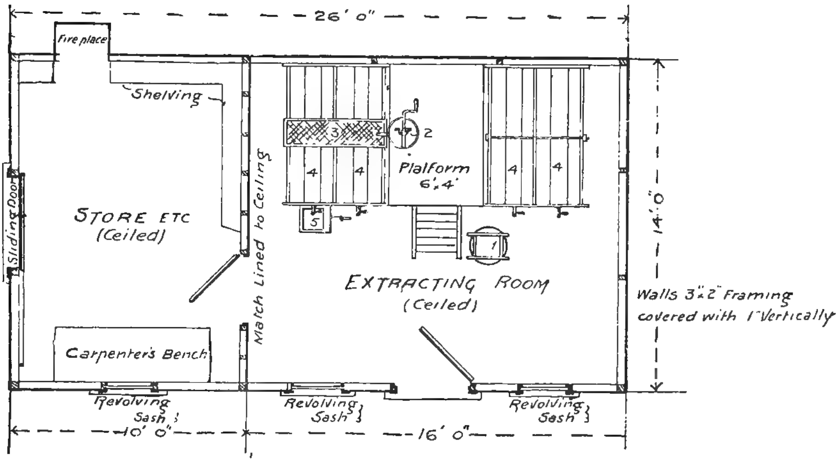
Plans and Specifications of Honey-store and Extracting-room.



Section of Honey-house, showing Extracting-stage.



Elevation of Honey-house.



Ground-plan of Honey-house.

Timber required for Honey-house as shown in Plan and Elevation.

Blocks, 4 in. by 4 in. sawn, or 6 in. by 4 in. split: 18, about 2 ft. long.

Ground and sleeper plates, 4 in. by 3 in.: 3, 16 ft.; 3, 11 ft. Platform, 3, 6 ft.; 3, 10 ft.

Floor-joists, 6 in. by 2 in.: 19, 14 ft.

Plates, 3 in. by 2 in.: 4, 26 ft. (or 4, 16 ft.; 4, 11 ft.); 4, 14 ft.; 4, 9 ft. raking-plates.

Studs, 3 in. by 2 in.: 22, 8 ft.; 2, 9 ft.; 5, 10 ft.; 3, 12 ft.

Rails, 3 in. by 2 in.: 4, 16 ft.; 4, 11 ft.; 4, 14 ft.

Braces, 4 in. by 1 in.: 5, 16 ft.

Rafters, 3 in. by 2 in.: 28, 9 ft.

Collars, 3 in. by 2 in.: 6, 13 ft.

Ridge, 8 in. by 1 in.: 1, 16 ft.; 1, 12 ft.

Purlins, 3 in. by 2 in. : 8, 16 ft. ; 8, 12 ft.
Fascias, barge and covers, 8 in. by 1 in. : 2, 16 ft. ; 2, 12 ft. ; 8, 10 ft.
Soffits, 8 in. by ¾ in. : 2, 16 ft. ; 2, 12 ft. ; 4, 10 ft.
Vertical boarding, 12 in. by 1 in. : 50, 9 ft. ; 4, 10 ft. ; 8, 11 ft. ; 8, 12 ft. ; 4, 13 ft.
Covers, 2½ in. by ¾ in. : 50, 9 ft. ; 4, 10 ft. ; 8, 11 ft. ; 8, 12 ft. ; 4, 13 ft.
Flooring, P., T. and G., 6 in. by 1 in. : 500 ft. B.M. to cut 14 ft. lengths.
Lining and ledged doors, P., T. and G., and B., 6 in. by 1 in. : 300 ft. B.M. to cut 14 ft. lengths.
Lining of ceiling, P., T. and G., and B., 6 in. by ¾ in. : 300 ft. B.M. to cut 14 ft. length.
Sills, doors and windows, 6 in. by 2 in. : 1, 17 ft. ; 1, 6 ft.
Steps to platform, strings, 6 in. by 3 in. : 1, 10 ft.
Steps to platform, steps, 8 in. by 1½ in. : 4, 2 ft.
Sashes, glazed, 3 : 5 ft. 6 in. by 2 ft. 10 in. (nine-light).

3rd October, 1905. W. A. CUMMING, Architect.

The cost of the material for the above building—timber at an average of 13s. 6d. per 100 ft. (exclusive of blocks), £21 10s. ; iron roofing and ridging, £5. If an addition of workshop and fumigating-room be made to the same building, as shown in Plate V, the total cost for material will be £45. The lean-to is 12 ft. wide, and the length of the honey-house.

NOTE.—The price of timber having advanced, the cost of such a building would be proportionately larger now.

Instead of the fireplace and iron chimney shown in plan, it was found more convenient to put in an American stove, as it heats the house better when required.

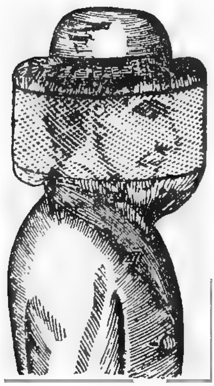
V. HANDLING BEES.

Before any person can be successful with bees he or she must be able to handle them fearlessly. It is to be expected that the beginner will feel some timidity at first, but a little experience should enable him or her to get over this. A lesson or two from an experienced beekeeper will prove the best help. I cannot give credit to the oft-repeated statement that bees have a particular aversion to some people. A person who thinks this of himself will feel nervous when near bees, and in that condition is likely to do something to irritate them, and unconsciously cause them to attack him. In my novitiate days, while I was learning how to handle them, I got a fair share of stings, and this I think is the experience with most people. Experience should bring confidence : if it does not within a reasonable time, I think it would be better for the person to drop out of beekeeping.

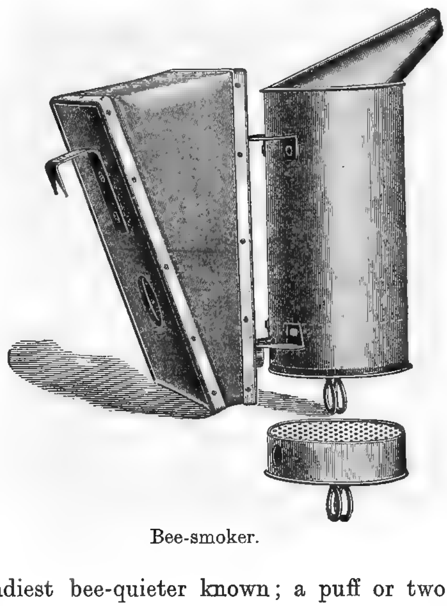
BEE-VEIL AND SMOKER.

All beginners should protect themselves with a bee-veil, and a smoker is absolutely necessary, both to the beginner and to the old hand, if he wishes to get through his work rapidly, without unnecessarily killing bees. As for gloves, to me they are a nuisance, therefore I never wear them. There are specially oiled cotton mittens supplied now, that might be much better than gloves, as the ends of the fingers are free. Gauntlets alone, or elastic bands around the sleeves, where a person is not working with bare arms, are useful to prevent the bees crawling up the sleeves.

Beware of using soft-leather gardening-gloves, as they do not protect the hands completely from stings, and they have the serious disadvantage that after being in use for a time they become more or less saturated with the poison of the sting, which is liable to be absorbed through the pores of the skin when the hands are warm, and so cause irritation of the cuticle in different parts of the body.



Wire-cloth Bee-veil.



Bee-smoker.

Smoke is the best and handiest bee-quieter known; a puff or two of pungent smoke will send the bees to their honey, and when they have filled themselves they are pretty docile, and can be handled readily if one is careful. The handiest fuel for the smoker is old dry sacking rolled up loosely.

HOW TO MANIPULATE A HIVE.

The smoker should be well alight and the bee-veil fixed. Blow a few puffs of smoke into the entrance of the hive (see Plate VIII); then wait for half a minute or so. Next remove the cover without jarring the hive.

It may be well to remark here that all movements about the hive should be quiet and deliberate, and there should be no jarring of any part of it, as nothing irritates the bees so much as jarring their hive. Lift one corner of the mat, and blow another puff or two down between the frames while removing the mat altogether (see Plate IX). By this time the bees should be pretty quiet, but keep the smoker near by, and if they begin to "boil" up over the frames, give them another puff or two of smoke. The frames may now be prized apart, and one of the side frames removed to make room to get at any of the others. When finished, the frames can be replaced in their original position and the hive be closed—a screwdriver or an old chisel is a handy tool to have.

The best time to handle bees is on fine bright days when they are flying freely and gathering honey. The beginner should never interfere with them on dull gloomy days if it can be avoided.

HANDLING FRAMES OF COMB.

When a frame of comb for any reason is lifted from a hive, it is usually desired to see both sides of it. To the experienced hand it is an easy matter to reverse it, but the beginner without some instruction would find it very awkward to do so, and with a new comb heavy with honey, and not well fastened to the bottom bar, he might turn it in such a manner that the comb would fall from the frame (see Plates, X, XI, and XII.

Plate X shows the first position of the frame while examining one side of the comb. Plate XI shows the second position: the left hand has been lowered and the right hand raised, while the frame has been partly swung round. In Plate XII the hands have been brought back to the first position, but the frame is upside down, and the other side of the comb has been brought in view; the same movements are reversed to bring the frame back to its first position. By handling the frame in this manner there is no strain whatever put upon any part of the comb, and nothing is done that will irritate the bees.

VI. WORKING BEES ON SHARES.

It is by no means an uncommon thing in some parts of America for one man to engage to work another man's bees on shares, and I have several times been called upon for advice on this matter in New Zealand. Though

not more than two or three instances have come under my notice where it has been carried out in this Dominion, I have no doubt that it will become more common as the industry of bee-farming progresses. The following briefly outlined scheme covers the ground, and is the usual one adopted: The owner of the apiary or bee-farm provides all the bees and appliances in good condition, and on the site where they are to be worked. The other works the bees right through the season to the best advantage, and finally fixes them up for winter, leaving a winter supply of food in the hives. The crop of honey is equally divided, each paying half cost of putting it up for market, or if each half is put up in a different manner each pays for his own packages. Should it be arranged to market together, each pays half the expenses and the net returns are divided equally. All increase to be the property of the owner of the apiary, he, of course, finding the hives. The person working the apiary will then find it to his advantage to keep down increase, and work for honey only.

PART II.—PRACTICAL ADVICE.

I. THE USE OF COMB-FOUNDATION.

The success of modern bee-culture hinges almost entirely in the first place on securing complete control over the breeding, and this can only be obtained by compelling the bees to build whatever kind of comb is desired. Under natural conditions, or when in hives and allowed freedom to construct their combs, they invariably build a goodly proportion of drone-comb, which is subsequently utilised for breeding drones. This accounts for the large number of drones to be seen in box hives, or where no attempt has been made to control breeding. Drones, as most people are aware, are non-producers — that is to say, they do not gather honey, or even, so far as we know, do any work in the hives. They are physically incapable, but they consume a large quantity of food gathered by the workers, and where many are present the yield of honey from that hive, and consequently the profit, will be considerably curtailed. Some drones are needed for the impregnation of young queens, but it is found in practice that a sufficient number for this purpose will be bred, even when the breeding of them is restricted as much as possible, by making the fullest use of worker-comb foundation.

The difference between worker and drone comb is in the size of the cells, the former measuring slightly over five to the inch, and the latter a little over four. The proportions are shown in Plate XIII. The comb-foundation obtained from manufacturers is invariably impressed with the bases of worker-cells, so that it is impossible, unless by accident some portion has stretched, for the bees to build other than worker-comb on it. The illustrations will make this clear. Plate XIV shows a perfect worker-comb built out on a full sheet of comb-foundation, while Plate XIII exhibits the result of the breaking-away of a portion and the stretching of another portion due to careless fixing of what was originally a perfect sheet of worker-comb foundation. These are very interesting reproductions from photographs taken specially for the purpose of this bulletin. To the right of Plate XIII can be seen where the bees took advantage of the accident to build drone-comb, and also where on the upper left centre the original worker-cells have stretched and been utilised for breeding drones. At the lower right-hand corner of Plate XIV a small portion of the original sheet of comb-foundation upon which the comb is built can be distinctly seen.

Securing control over breeding is not the only advantage gained by a free use of comb-foundation. For instance, a fair swarm of, say, 5 lb. weight hived upon ten sheets of comb-foundation in a Langstroth hive will have in twenty-four hours, in an average season, several of the sheets partially worked out and a goodly number of eggs deposited in the cells, and in thirty-six hours the queen can henceforward lay to her full extent. In from a week to nine days (depending upon the weather) the whole ten sheets will be worked out into worker-combs, and a great deal occupied with brood and honey, and the hive will then be ready for the top or surplus honey super. In twenty-two or twenty-three days young worker-bees will begin to emerge, and from this on the colony will grow rapidly in strength from day to day.

Contrast this favourable condition of things with what takes place when only narrow strips of comb-foundation are furnished. It will take under the same conditions a similar swarm from four to five weeks to fill the hive with comb, and then there will be a large proportion drone-comb, which is the very thing to guard against. Consider what the difference i time alone will make in the profitable working of a hive, especially in a short season. Then, again, with regard to the difference in the initial expense between using full sheets and strips, which seems to influence many beginners in favour of the latter system: Even in that there is a gain in favour of the method I am advocating. For instance, the cost of filling the ten frames with sheets of best comb-foundation would be (including the expenses of getting them) about 4s., and with strips—say, two sheets—10d.: an apparent saving in the first instance of 3s. 2d. We must then consider the matter from another point of view.

The consensus of opinion among the most experienced beekeepers is that there is an expenditure of about 12 lb. of honey in making 1 lb. of wax—that is, the bees consume that quantity of honey before secreting 1 lb. of wax. The ten sheets of comb-foundation weigh 1½ lb. and cost 4s. For this there would have to be an expenditure of 18 lb. of honey, which, at the average wholesale price of 4d. per lb., is 6s., so that there is a saving of 2s. in favour of the full sheets, to say nothing about all the other advantages gained.

This shows clearly enough the advantage of making the fullest use possible of comb-foundation.

II. THE RIPENING AND MATURING OF HONEY.

All honey should be thoroughly ripened and matured before being placed upon the market; otherwise it will rapidly deteriorate, to the injury of the producer and the industry generally. All beekeepers are

fully aware of and admit this; nevertheless, occasionally unripe honey has found its way to the markets, eventually to be condemned through fermentation. In the absence, however, of a simple and reliable method for deciding when honey is ripe, beekeepers are not wholly blamable for being mistaken on this point.

AMOUNT OF MOISTURE IN HONEY.

Nectar or honey when first gathered contains a variable quantity of water, usually ranging from 18 to 23 per cent., according to the weather. Mr. Otto Hehner, F.I.C., F.C.S., public analyst, and analyst to the British Beekeepers' Association, in a lecture before that body some years ago stated, "Essentially, honey consists of water and of sugar. Of the water I need say but little except that I have found it to vary in quantity from 12 to 23 per cent., the normal proportion being from 18 to 21 per cent. When the percentage falls below 18 the honey is generally very hard and solid; when it is higher than 21 it is frequently quite or almost clear."

In Thorpe's "Dictionary of Applied Chemistry," page 286, the maximum, minimum, and average amount of moisture in twenty-five samples of honey examined are given as follows: Maximum, 23·26 per cent.; minimum, 12·43 per cent.; and the average of the twenty-five, 19·3 per cent.

Recently some important investigations have been made by the United States Department of Agriculture regarding the "Chemical Analysis and Composition of American Honey." Some 100 samples were procured, and placed in the hands of Dr. C. A. Young, a skilful sugar chemist, and regarding the moisture in the honey he says in his report,—

> The average amount was 17·90 [per cent.], with a range of from 12·42 to 26·88. This shows that American honey is 3 per cent. drier than German honey, and German honey is drier than British. This is due to our drier climate. . . . . Nevada honey is drier than that of Missouri, the former had only 14·61 per cent. of water, and the latter State 19·57 per cent. It is a truism to say the locality having the highest rainfall has the highest percentage of water in the honey produced.

This latter assurance is just what one might expect, and worthy of consideration when choosing a location for bee-farming.

Honey containing an excess of moisture is unripe and bound sooner or later to ferment, but when such moisture is reduced below a certain percentage the honey is said to be ripe, and it will in that condition keep good for any length of time. There is in the Agricultural Museum at Wellington a sample over seventeen years old, in splendid condition. At what point the "excess" of moisture commences we have no definite knowledge. The different works available contain no guidance on the question.

It is extraordinary that, considering the importance of the subject, the ripening and maturing of honey has never been scientifically discussed in bee literature—at any rate, in the best that has appeared for over thirty years. There have been volumes of vague statements and assertions by correspondents in the various bee journals, but nothing of value.

TESTING HONEY FOR RIPENESS.

My former experience as a honey-merchant brought me into contact with all sorts and conditions of beekeepers, and all sorts and conditions of honey—in its qualities of ripeness and unripeness. I then realised the need there was that beekeepers should have some simple but reliable method of testing honey for its ripeness before putting it up for the market. It was frequently very difficult to decide whether honey was ripe or not while it was in liquid form; and to-day the same difficulty obtains, demanding every effort to remove it.

It is beyond the accomplishment of the average beekeeper to ascertain by evaporation the exact amount of moisture a given sample of honey contains, and until some simple method is available (see "Remarks" at end of this chapter) we must try to reach the same end by density or specific-gravity tests.

SPECIFIC GRAVITY OF HONEY.

Previous to carrying out a series of tests of a number of samples of honey (which I shall explain directly) I consulted several works in hope of getting some assistance from them, but was disappointed. The *British Bee Journal* for December, 1885, contained the only item on this matter in all my bee literature. The then editor, in reply to a correspondent, gave figures from different works representing the specific gravity of honey, ranging from 1·261 to 1·450, and then suggested taking the mean of these figures—viz., 1·355—"as a conventional standard for ripe honey," admitting, at the same time, that "clover honey in a dry season is found to be 1·370." This was a very haphazard way of deciding so important a question. Thorpe's work, already referred to, gives, on page 287, a range from 1·439 to 1·448 as the specific gravity of honey; another equally well-known work gives from 1·425 to 1·429 for "virgin honey"—whatever that may be—and from 1·415 to 1·422 for "honey from old bees" (?); and the "Encyclopædia Britannica" gives 1·410. The foregoing figures, instead of affording any assistance, are, on the contrary, rather misleading with regard to the actual density of ripe honey.

TESTS MADE.

Some eighteen months since I purchased from grocers in the ordinary way twenty tins of different varieties and grades of honey, and tested them very carefully for their specific gravity with a Twaddel's and a Fletcher's

hydrometer. Before testing, the condition of each sample was noted, in order to compare the specific gravity with its appearance. Eleven samples ranged from 1·400 to 1·430, with an average of nearly 1·413, while the remaining nine ranged from 1·350 to 1·390. Those above 1·410 were very firm and dry before testing, and the whole twenty samples were granulated. Those from 1·400 to 1·410 appeared to be well ripened, but were not so firm as the others; there was a marked difference in those below 1·400, which were soft and moist. My opinion is that the first-mentioned were thoroughly ripe and would keep any length of time; the second lot, ranging from 1·400 to 1·410, were well-ripened and fit for the market; while all the samples registering below 1·400 were very doubtful regarding their keeping-qualities—one at 1·385 had already begun to ferment. These figures will be valuable for comparison with those of future tests. A portion of each sample is being kept sealed to test by time. It was very noticeable that the better the honey the higher was its specific gravity.

Other tests of a similar nature were carried out by the then honorary secretary of the Southland Beekeepers' Association, who, at my request, collected seven samples of honey from different parts of Southland. Six of the samples ranged from 1·420 to 1·450 in their specific gravity by Twaddel's hydrometer, and are described generally as "clover honey, granulated very hard, fine grain and flavour, thoroughly ripened." The seventh sample is described as of "poor quality compared with the others, and doubtful as to its keeping-qualities, granulated, but soft: specific gravity, 1·402."

In addition to the above, some fifty tests have since been made, chiefly of white-clover honey, the samples of which were considered well ripened. Most of them ranged from 1·420 to 1·435, while some samples of mixed varieties averaged 1·415.

I feel confident that we shall be able, after another season's experience and many additional tests, to formulate an approximately correct standard of specific gravity for our best honey that will denote its fitness for market. The tests already made indicate that clover honey of a specific gravity of 1·420 and over is fit for market, and the higher the specific gravity the better.

METHOD OF TESTING.

Each sample was liquefied by slow heat in a closed vessel (to prevent the moisture evaporating) placed in a water bath. It was then reduced to a temperature of about 60° Fahr., poured into a test-glass, and the hydrometer inserted (see Fig 2). The hydrometer will gradually sink until it finally registers the specific gravity. In the case of honey being too dense to be treated in this manner, weigh up, say, 8 oz. of honey, then add the same weight of warm water, and thoroughly mix; when reduced to 60° Fahr. it will be ready for testing. Supposing, for instance, the hydro-

meter then gives 1·190, by adding 190 it will give 1·380, which will be the specific gravity of the honey.

The cost of the appliances is a mere nothing compared with the importance of making tests, as every beekeeper should assist in arriving at a reliable standard for ripe honey. A Twaddel's hydrometer (Fig. 1), or two instruments with a range from 1·350 to 1·400 in one and 1·400 to 1·450 in the other, with a suitable test-glass and thermometer, cost about 7s. 6d. or 8s.

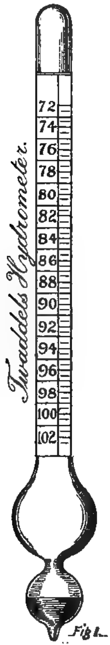


Fig 1.

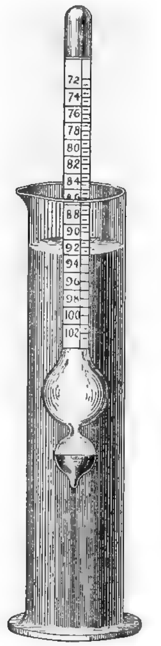


Fig 2.

The instrument is made with various scales, according to the density of the liquid to test which it is required.

Each degree is equal to 5 degrees specific gravity; for example, 80 degrees Twaddel is equal to 1·400 sp. gr. as $80 \times 5 = 400 + 1,000 = 1·400$ sp. gr.

RIPENING HONEY INSIDE AND OUTSIDE THE HIVE.

This subject has caused no end of controversy in the bee journals, but chiefly by those bitterly opposed to any other method of ripening honey than within the hive. Although I have closely followed most of the writers on this side of the question, I have failed entirely to discover anything beyond mere assertions that their method is the right one, and all others wrong. No proof by tests or experience of both methods has been adduced to support their assertions, so that to a close observer they have been value-

less. On the other hand, we have the experience and testimony of some very eminent beekeepers who have practised with great success and advantage the ripening of honey outside the hive.

Ripening inside the Hive.

This can readily be done, and is, no doubt, the best plan for those who are not prepared to exercise great care—that is, who ar somewhat careless. All that is needed is to leave the honey in the hive until all the cells are sealed or capped over before removing the comb for extracting. The capping of the honey-cells denotes that the contents are ripe. There are some beekeepers, however, who think this is not so in all cases, and that the honey is better when allowed to remain in the hive for some time after it is capped. The time elapsing between the storage and the capping of the honey depends in a great measure on the state of the weather and the condition of the honey when stored; it may be several days before the honey is capped, or in dry warm weather only a few hours after the cells are filled. Even honey that is ripened in the hive should remain in a shallow tank after extracting, to mature before tinning it. But more of this later.

Ripening outside the Hive.

If there were no disadvantages in the foregoing process, or no other method of reaching the same end without disadvantages attached to it, we should, as a matter of course, have to follow it; but I maintain, in the absence of direct chemical proof to the contrary, that we can produce as fine honey for marketing purposes by ripening outside as within the hive, and by so doing effect an enormous saving of time, labour, and material, and secure a larger crop of honey. Nothing has yet been brought forward to refute the theory that the ripening of honey, as previously stated, is simply a mechanical process—evaporating the surplus moisture by means of heat, whether inside or outside the hive.

Dr. E. F. Phillips, in a letter to me on this subject, says that in addition to the evaporation of the water the sugars are modified very decidedly in the ripening. Further, he says, "We have found that honey is subject to some peculiar changes in its sugar-content after it has been throughly ripened, and an effort is now being made to find out what these changes are, and their causes."

In the season of 1883–84, after much thought, I determined to give the process a trial, and had shallow tanks made, such as I recommend now. The crop was ten tons of clover honey, none of which was more than partially capped on the upper parts of the combs, and plenty was not capped

at all when extracted. It was duly ripened and matured in my tanks, and finer honey I never had. It was sent to England and all over the Dominion, and gave no cause for complaint. I followed the same process with similar success all the time I was raising honey, and the same system is now practised at the State apiaries.

It gave me much pleasure some seven months after the publication of the first edition of this bulletin, wherein I had suggested the adoption of this process, to find that the well-known E. W. Alexander, one of the most extensive and experienced beekeepers in the world, was working on the same method. His articles on the subject in *Gleanings*, early in 1906, created quite a sensation among the beekeepers in America, some of whom rather fiercely criticized him and his method, and in reply he wrote, " But I do say that the man who has had experience, and has the necessary storage-tanks, can ripen his honey after the bees commence to cap it so that it will be just as good as if left with the bees all summer. In this way we not only get twice the amount, but we save our bees much labour and waste of honey in capping it over, and ourselves at least half the work in extracting." I may add that by ripening honey outside the hive swarming can be better kept under control.

During a heavy flow of honey when it is left in the hive to ripen it is necessary to keep adding top boxes to take advantage of the flow, as the honey will be stored faster than it can be ripened. This means the providing of a large quantity of extra material and combs at considerable cost. Each top box would be worth at least 2s. 6d., and the nine frames of comb at 1s. 3d. each, 11s. 3d., making a total of 13s. 9d. ; and two of these extra boxes may sometimes be needed for each hive if full advantage is to be taken of the conditions mentioned.

RIPENING AND MATURING TANKS.

The most effective method of ripening and maturing honey is to expose a large surface of comparatively shallow mass to a warm, dry, atmosphere. Many of the " tanks " in use at the present time consist of cylinders similar to those of a honey-extractor, about 18 in. or 20 in. in diameter, by 36 in. deep. These, besides being small, are wrong in principle—they are too deep, and the surface is too small. Even when the honey is allowed to ripen within the hive it is necessary to have shallow tanks to mature or clarify it, for, no matter how small in the mesh the strainer may be or how carefully the honey is strained, it is impossible to prevent very fine particles of wax and pollen-grains running from the extractor into the tank with the honey. If the body of the honey is deep these particles cannot rise to the surface as they do in a shallow tank, forming a scum, which, when skimmed off, leaves the honey in the very best form for market. Air-bubbles, which in

themselves may contain moisture (and it is absolutely certain that honey containing air-bubbles quickly deteriorates), cannot rise or escape through a deep mass of honey.

With regard to the scum just mentioned, it is by no means uncommon to find an unpleasant-looking film, or layer, anywhere between $\frac{1}{8}$ in. and $\frac{1}{4}$ in. deep on the top of honey in tins sent into the market. This is the result of tinning it before it has been matured and skimmed, probably in most cases through not having a suitable tank for the purpose. Honey, like other commodities, must be put upon the market in its most attractive form if we wish to encourage the demand for it.

HONEY-STRAINERS.

The strainer in use at the State apiaries consists of a long shallow tin box without a cover, and with one-half the bottom formed of fine wire gauze, and the other half of tin. This box reaches right across the double tank (see page 39), and by turning it end for end the honey can be run into either division. Inside the box two other loose strainers slip, the upper one is a coarse strainer to catch dead bees, large pieces of wax, &c., and the under one finer. These can be taken out and cleaned when required.

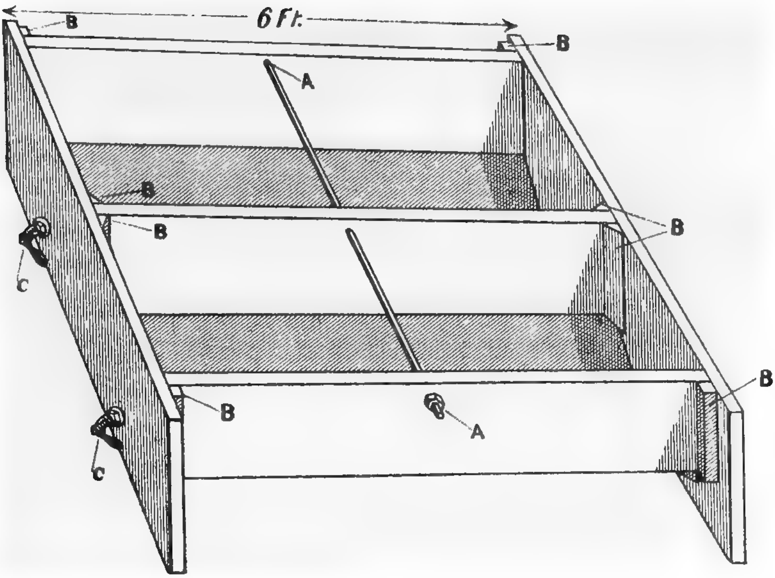
A good plan, if the contour of the ground will allow of it, is to arrange the honey-tank at a level 3 ft. or so below the extractor and strainer, so that the honey, after passing through very fine meshes and thus being split up into fine threads, shall fall that distance before reaching the tank. The atmosphere being warm and dry, will absorb very much of the moisture in the honey in its descent.

SIZE OF HONEY-TANKS.

This is a matter which most bee-farmers will decide for themselves according to their needs and convenience, and it only remains for me to indicate the depth I have proved by experience to be all that is required in a ripening and maturing tank.

I prefer tanks not deeper than 20 in., and they should not, even when working on a large scale, exceed 24 in. Mr. E. W. Alexander used deeper tanks, but finds them too deep, and recommends shallower ones.

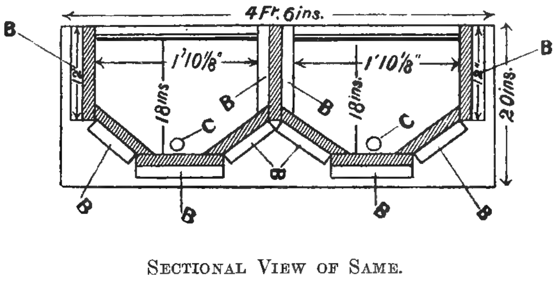
For an apiary of, say, two hundred colonies, two such tanks as the double tank illustrated would in most cases answer the purpose. There is a great advantage in dividing the tanks into compartments, so that the honey from each day's extracting may be left undisturbed until it has matured and is ready to run into tins. It is unwise to run two or three days' extracting into the same tank, as the frequent disturbance is against the honey maturing properly.



Double Honey-ripening Tank.

(Not drawn to scale.)

The above represents a honey-ripening tank, 6 ft. long, 4 ft. wide, and 20 in. deep, outside measurements, capable of holding about 1,250 lb. of honey in each compartment. It should be made of $1\frac{1}{4}$ in. timber, and lined with good stout tin.



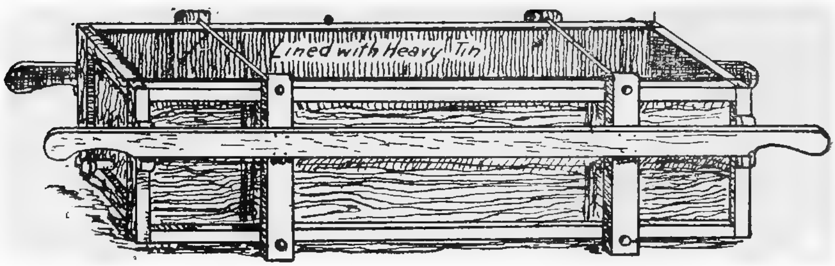
Sectional View of Same.

In both cuts the letters refer to the same parts. A, A, iron strengthening-rod, with screw-nut; B, B, battens $2\frac{1}{4}$ in. wide by 1 in. thick, against which the boards of the tank are nailed; C, C, honey cut-off taps.

The illustrations, so far as the measurements are concerned, represent the tanks in use at the Government experimental apiaries, and, in whatever size may be considered desirable, something near the same proportions are advisable, and at most not more than 24 in. deep.

E. W. ALEXANDER'S HONEY-TANK.

The following illustration represents one of Mr. Alexander's honey-tanks, which is portable, and holds something near 5,000 lb., but, as I said before he considers its depth too great.



ALEXANDER'S STORAGE AND EVAPORATING TANK.

HEATING THE HONEY-HOUSE AT NIGHT.

It sometimes happens during the extracting season that the temperature falls very low during the night, and may cause honey in the tank to partially crystallize prematurely. To avoid this it is advisable to adopt some means of keeping up the temperature on such occasions. Some kind of modern oil-stove, free from any smell that would taint the honey, might answer the purpose.

TESTING STRENGTH OF LIQUID FOR MAKING HONEY VINEGAR.

The washings of cappings (when there are any), the skimmings and washings of the tanks, honey-extractors, &c., broken honey-combs, and other odds and ends of honey need not be wasted; all can be utilised in the making of vinegar or mead, or both. A hydrometer comes in very useful here again to test the strength of the liquid. For vinegar there should not be more than $1\frac{1}{4}$ lb. of honey to each gallon of water, the specific gravity of which is 1·040, so that when the honey cannot be weighed the hydrometer will at once show whether the strength is right, instead of depending on guesswork.

LIQUEFYING GRANULATED HONEY.

I wish to caution beekeepers against overheating when liquefying granulated honey. The usual advice given is that it may be heated up to 160° Fahr. without doing harm to the honey. From close observation I am satisfied that much of the fine aroma and flavour characteristic of our best honey is lost when slowly heated up to anything near that temperature.

To avoid injury the honey should not be heated many degrees above the normal temperature of the hive in summer—say, about 110°. I am fully aware that granulated honey will take a long time to liquefy at that temperature, but better that than injure it.

REMARKS.

The object of the foregoing chapter is to bring about a condition of things generally whereby we shall have a reliable system for preparing and placing on the market our honey in its best form, a matter to which much attention has been given since it was first brought forward in the previous edition of this bulletin. The use of the hydrometer in testing honey for its fitness for market has been favourably commented upon by the editors of American and Australian bee journals, and many of our beekeepers now use the instrument.

With regard to the question of ripening honey outside the hive, there are still many who question the efficiency of this method, and others who oppose it entirely. On the other hand there are an increasing number who are giving it a trial, besides many who have accepted it. I would further remark that what I have said on the matter is based not upon theory, but upon actual practical experience. It remains, however, for each individual beekeeper to please himself as to whether he will ripen his honey outside or inside the hive; but the question is of such vast economical importance in the matter of profit and loss that it will be well for those in doubt to give both methods a fair trial side by side and decide for themselves.

III. DEALING WITH THICK HONEY.

One of the few serious drawbacks beekeepers in certain districts have to contend with occasionally is thick honey—that is, honey that is too dense to extract from the combs in the ordinary way. I say "occasionally," because fortunately it is not met with every season, except, it may be, in apiaries situated near heavy bush, or where little else than flax or tea-tree abounds, in which case it would be folly to attempt to raise extracted honey.

Now and again beekeepers in the Waikato districts suffer considerable loss and are put to extra trouble through the storage of thick honey, although in the midst of clover country. The same occurs in a few other districts in the Dominion. There are some parts—notably, nearly the whole of the country north of Auckland—where the honey is continuously of so

dense a nature that the honey-extractor is of no use whatever. Such country, at present, is not suitable for bee-farming, as only comb-honey can be raised there, and the demand for this is limited, while it is too fragile to be sent to distant markets with profit.

FLORA FROM WHICH THICK HONEY IS GATHERED.

So far as the Waikato is concerned, I am of the opinion of one of the oldest and most experienced apiarists in the district—Mr. Joseph Karl—that it is gathered chiefly from tea-tree blossoms. There are two varieties of this plant —one known as "red" tea-tree, from the colour of the wood, and the other "white." They frequently grow together, and the blossoms are much alike in appearance, but a difference can be distinguished on close inspection. I have seen the hive-bee working on the "red" variety, but never on the "white"—the little native bee works on the latter. In warm, dryish seasons—what may be termed good clover seasons—there is little or no trouble with thick honey, but in wet, unfavourable seasons, like that of 1906–7 in the Waikato, the difficulty is very serious, owing, no doubt, to the clover yielding very little honey and the bees being forced to the tea-tree or other forage. Waikato beekeepers may console themselves with the fact that the tea-tree scrub is rapidly disappearing from the country, and clover pastures taking its place.

MAKING THE BEST OF THE DIFFICULTY.

For the benefit of the many beekeepers who meet with the same drawback, I will describe the practice followed by the late Mr. G. S. Pearson, of Hamilton, Waikato, formerly president of the Waikato Beekeepers' Association, which is that generally followed in the district.

The storing of thick honey commences early in the season, but ceases as soon as the weather is favourable for gathering clover honey. Should this latter condition not come about, the first continues and gives trouble. Should there be a comparatively small quantity of thick honey stored, but more than is needed for immediate use as food, the combs when sealed are removed and stored away for the bees' future use, every particle of extractable honey is taken from the hives to the end of the season, and the thick honey returned for winter stores. Should, however, there be more of the latter than can be utilised in this way, as there frequently is, it is put through the honey-press.

HONEY-PRESS.

Mr. Pearson's press (see Plate XV) is similar to those in general use in the Waikato. It is, as can be seen, an ordinary single cheese-press of the latest design, with screw and compound lever, fitted up for the purpose required.

The "receiver," into which the honey runs as the combs are pressed (shown at bottom of Fig. 2), is $20\frac{1}{2}$ in. square and 6 in. deep, outside measurement, formed of 6 in. by 2 in. boards. Two 6 in. by 2 in. bearers are nailed across the inside, as shown, at equal distances from the sides, and are chamfered on tops. They are to help bear the weight of the body when under pressure. A $1\frac{1}{8}$ in. batten is nailed around the top edge to act as a stop, inside of which the lower edge of the body fits when in place. The bottom should be of 1 in. or $1\frac{1}{4}$ in. timber, and should be leakage-proof, and the honey should be free to run from each compartment to the spout.

The "body" (shown in centre of Fig. 2) is 18 in. square and $15\frac{1}{2}$ in. deep, outside measurement. Battens 3 in. by $\frac{3}{4}$ in., chamfered on upper edge, are nailed on edge across the bottom 1 in. apart, and in the opposite direction or at right angles to the bearers in the receiver. Fillets $\frac{5}{8}$ in. square are nailed vertically $\frac{3}{4}$ in. apart all round the inside, and over these and the battens on bottom galvanised wire netting of $\frac{1}{2}$ in. mesh is fastened, and small fillets are nailed over raw edges at the joints and around the top edge.

The "follower" (shown in upper part of Fig. 2, just under the screw) is a large box 6 in. de p, a trifle smaller than the inside dimensions of the body in the square. The top and bottom should each be in one piece, and before nailing on the top a bearer the full depth should be nailed across the centre. The whole of the follower is made of sound 1 in. timber. A chain with hook and strap is attached to each side for the purpose of drawing it out of the body after use, and the body should be secured from below to keep it in place when lifting the follower. The two blocks on the ground in Fig. 2 are 6 in. square and 12 in. long in one case, and 6 in. by 3 in. and 12 in. long in the other. These are shown in place on top of follower in Fig. 1.

Pressing : Before the combs to be pressed are put into the body, sufficient cheese-cloth is placed in the latter to hold the combs and lap over the top under the follower. The latter is then placed in position, and the screw brought into play. As the screwing proceeds the arm of the compound lever rises, and when full pressure is on it can be left, as the lever then acts and retains the pressure till the arm falls to its lowest point.

Mr. Pearson stated that one man pressed out 75 lb. honey in an hour and a half. He also remarked that, if fitting up another press, he would make the receiver 4 in. deep instead of 6 in., and the body 13 in. instead of $15\frac{1}{2}$ in. deep.

The press without the fittings cost, when new, about £5, but a second-hand one in good order may often be got for much less.

Pressed honey is not nearly so good as that extracted in the ordinary way. It is not of so high a grade in the first place, and the flavour is not improved by pressing. Honey to be pressed should be thoroughly ripe

before removal from the hive—that is, all capped over, as it is so dense that there would be little chance of getting rid of any surplus moisture afterwards.

OBJECTIONS TO THE USE OF QUEEN-EXCLUDERS.

Queen-excluding honey-boards, now better known as "queen-excluders," are valuable for use in special cases, such as in queen-rearing; but for the purpose for which they are usually employed—that is, for confining the queen to the lower story of the hive during the honey season—I have no hesitation in saying they are unsatisfactory, and against the most profitable working of an apiary. The one and only valid reason for their use is that they prevent the queens from breeding in the combs of the upper stories, in which we look for the surplus honey to be stored. There is no gainsaying that this is a great convenience, and would warrant their use were their advantages in this respect not more than counterbalanced by great disadvantages and loss in others.

In the third edition of my "Australasian Bee Manual," published in 1886, I pointed out some of their disadvantages. Further experience has strongly confirmed my first impressions, and brought to light other evils connected with their use. Very few experienced beekeepers use queen-excluders, but I have met with a number who have used and discarded them. It is, however, the beginner who is apt to be misled, and it is chiefly to guide him in the most profitable working of his bees that this bulletin is published.

The most important point to observe during the honey season in working to secure a maximum crop of honey is to keep down swarming, and the main factors to this end are ample ventilation of the hives, and adequate working-room for the bees. When either or both these conditions are absent, swarming is bound to take place. The free ventilation of a hive containing a strong colony is not so easily secured in the height of the honey season, even under the best conditions, that we can afford to take liberties with it; and when the ventilating-space between the lower and upper boxes is more than half cut off by a queen-excluder, the interior becomes almost unbearable on hot days. The results under such circumstances are that a very large force of bees that should be out working are employed fanning, both inside and out, and often a considerable part of the colony will be hanging outside the hive in enforced idleness until it is ready to swarm.

Another evil caused by queen-excluders, and tending to the same end—swarming—is that during a brisk honey-flow the bees will not readily travel through them to deposit their loads of surplus honey in the supers, but do store large quantities in the breeding-combs, and thus block the breeding-space. This is bad enough at any time, but the evil is accentuated when it occurs in the latter part of the season. A good queen gets the credit of laying from two to three thousand eggs per day: supposing she is blocked

for a few days, and loses the opportunity of laying, say, from fifteen hundred to two thousand eggs each day, the colony would quickly dwindle down, especially as the average life of the bee in the honey season is only six weeks.

A short time ago I came across a strong colony with almost as many bees hanging outside the hive as would have made a decent swarm. Seeking the cause, I found an excluder on, and the breeding-space blocked with honey. I took it off and put on another top box filled with frames of comb-foundation. All the bees that had been hanging out in enforced idleness went to work at once, and when I examined the hive a week afterwards, the ten sheets of foundation were worked out and a good deal of honey stored in them. What, however, was of the highest importance was that most of the honey had been carried up from below, and the queen had taken advantage of the extra room provided her by the bees to lay in.

For my part I care not where the queen lays—the more bees the more honey. If she lays in some of the super combs it can be readily rectified now and again by putting the brood below, and side combs of honey from the lower box above; some of the emerging brood also may be placed at the side of the upper box to give plenty of room below. I have seen excluders on in the latter part of the season, the queens idle for want of room, and very little brood in the hives, just at a time when it is of very great importance that there should be plenty of young bees emerging.

IV. SPRING FEEDING OF BEES.

Next in magnitude to the losses of bees which result from inattention to disease are those which occur in the spring months through starvation. Few but experienced beekeepers and those who suffer financially from losses realise how readily the food-supply may become exhausted after breeding is in full swing in spring. In my rounds hitherto I have found it a general complaint that numbers of colonies have died off in the spring. The owners did not know the cause, and when starvation was suggested they were quite surprised, as they "had left plenty of food in the hive the previous season," and it had never occurred to them that the supply might run short. All beekeepers worthy of the name will take care that their bees never run short of food, be it spring, summer, autumn, or winter.

THE CAUSE OF STARVATION.

Given a fair supply of stores in late autumn, when fixing the bees up for winter, a colony will use comparatively little during the winter months, but as soon as breeding begins in the latter part of July or early August

the stores are largely drawn upon for feeding the brood, and unless nectar can be gathered to help them out, the stores will rapidly diminish. As a rule willows and other spring forage afford a good supply in fine weather, but the weather is frequently far from fine at that time—generally unsettled, and against the bees securing nectar. Take a case, for example, where the bees have come out of winter quarters with a fair supply of food in the hive, the weather fine, and some nectar is being brought in from the fields. Under these conditions, where there is a good queen, breeding will go ahead very rapidly, and in a short time there will be a big lot of brood to feed, and a large quantity of food needed. If at this time bad weather should set in and last for several days, preventing the bees gathering nectar, probably within a week pretty nearly all the reserve stores within the hive will be used up, and if the bees are not seen to before they arrive at this stage they will probably die of starvation. This is not a fancifully drawn case, but a real practical one, and shows just how such large losses occur in spring.

WHEN AND HOW TO FEED.

Experienced beekeepers can judge in a moment by the weight of the hive, without opening it, whether the supply of food is running short or not, and every beekeeper should learn to do this. By putting one foot on the back of the bottom board to keep it steady, and with one hand raising the back of the hive, one can get the weight at once, and after a little practice can judge to within 1 lb. the amount of honey inside. In this way a large number of hives can be examined in ten or fifteen minutes, and those needing food should be marked.

The safest and best food to give, unless frames of honey from known clean hives are available, is sugar-syrup. Make it as described in Chapter VI, under the heading of "Feeding and Disinfecting." Never purchase honey or accept it as a gift to feed your bees with—it is too risky, and to sterilise it would require two or three hours' boiling, which would be more trouble than the honey would be worth.

FEEDERS.

There are several kinds of feeders advertised by those who cater for beekeepers. Clean, empty combs make excellent feeders, and they can be filled by placing them on an inclined board in a large milk-dish or other similar vessel, and pouring the syrup through a fine strainer held a foot or so above them. The force of the falling syrup expels the air from the cells, and the syrup takes its place. After filling, the combs should be suspended over a vessel (to catch the drip) before placing them in the hives.

There are "division-board" feeders to hang in the hive like frames, and others to place over the frames, such as the "Miller" and "Simplicity" feeders; also the "Alexander" feeder under the bottom board, either of which will answer the purpose, provided attention is given to replenishing the food when needed. The inexperienced should always feed *within the hive*, and in the evening.

With regard to the Alexander feeder, its position outside the hive makes it less suitable for feeding in cold weather than an inside one. The syrup would get about as cold as the surrounding atmosphere, which would chill any bees that might go for it when the temperature is low. Small quantities of warm syrup might be fed at such times, just so much as could be quickly carried away.

Finally, remember that a little food given in the spring to tide the bees over a spell of bad weather will save them to give you a large return in honey later on, whereas neglect in this respect will result in their loss.

V. THE SOLAR WAX-EXTRACTOR.

This is an appliance which, speaking from experience, I consider should have a place in every large apiary. The conversion of old and broken combs, &c., into commercial beeswax is as a rule very disagreeable and unsatisfactory work with the water and steam appliances generally used. A fair quantity of wax-material must be allowed to accumulate before it is worth while to start work. This gives an opportunity for the wax-moth to start its work first, with the result of waste, beside the propagation in vast numbers of an enemy of the bee. Seeing that we have the large wax-moth with us, every scrap of old and broken combs, when of no further use, should be melted up at once, and there is no appliance so suitable for doing this right off than a properly constructed Solar wax-extractor.

The one shown in Plate XVI was in use at the Exhibition Model Apiary, Christchurch, and it acted splendidly. My previous experience of these wax-extractors had not favourably impressed me; they worked satisfactorily with new combs, but failed to extract more than about 50 per cent. of wax from old-brood combs. I subsequently discovered the cause of failure: they were made too deep—about four times the depth inside of the one shown, which is made on the "Boardman" principle:—

The dimensions outside are—length, 5 ft. 3 in.; width, 2 ft. 8 in.; depth of main part of body 4½ in.; wax-receptacle at lower end of body 9 in. wide by 8 in. deep. Sash (not shown in plate) is furnished with two sheets of glass with an air-space of 1 in. between them. The wheel on which

the extractor is mounted is 4 ft. 6 in. diameter, and works on an axle about 2 ft. long, driven into a block of wood in the ground. The body of the wax-extractor is lined with black sheet iron turned up at the sides, and fitting loosely in the extractor. A long tin divided into three compartments fits in the lower part for catching the wax as it runs from the combs. The tin and the divisions should run smaller at bottom than at the top, to facilitate turning out the cakes of wax, and the tops of the two divisions should be $\frac{3}{4}$ in. below the top of the tin. The middle compartment will then retain any dirt or foreign matter running in with the wax, while the clean wax will flow over into the outside compartments.

Two others have recently been made for the State apiaries, but instead of having the glass the full length of the sash, which in so large a size is very expensive, a thin bar runs across the middle so as to take two smaller sheets.

Although the one shown in use at the Exhibition was not specially sheltered, the temperature, as tested inside the extractor, frequently went over 220° Fahr., and on one occasion it went up to $231\frac{1}{2}$°, or $19\frac{1}{2}$° above boiling-point. The refuse from old combs—"slumgum," as the Americans call it—came out of the extractor as dry as possible, without a particle of wax left in it, and the wax extracted was always of a nice clean yellow colour.

With the exception of perhaps the sash and the metal parts, there is nothing difficult about the making of such an extractor to a man handy with tools. The woodwork must be substantial and thoroughly well seasoned to stand the great heat, and must also be well put together, otherwise it would soon fall to pieces. Screws are better than nails in the woodwork. It is advisable to bind the edge of the sashes with $1\frac{1}{2}$ in. angle iron. The depth inside from the lower sheet of glass to the iron lining should not exceed from $2\frac{1}{2}$ in. to 3 in. The wheel, of course, is handy for turning the extractor to the sun, but is not absolutely necessary if one cares to lift it round when required.

If in a warm corner of the apiary and well sheltered, the extractor would work at almost all times when the sun is shining. Such an appliance will soon pay for itself in a fair-sized apiary, for every particle of comb can be put in at once and converted into good commercial beeswax instead of being wasted.

VI. DISEASES OF BEES AND THEIR TREATMENT.

The hive-bee (*Apis mellifica*), like all other animals, especially those under domestication, is subject to several diseases, some fortunately of minor importance. The most injurious are those which attack and destroy the brood, thus preventing the normal development of young bees, and the inevitable result of which, when allowed to run their course, is the rapid decline and ultimate extermination of the colonies affected.

FOUL-BROOD.

The most pernicious of bee-diseases is what we know as "foul-brood," a germ disease of a very infectious nature, and only too familiar to the majority of beekeepers. It is, without doubt, the greatest drawback to successful bee-culture known at the present time, and seems to be prevalent in all countries where bee-culture is followed.

Historical.

Without delving deeply into the history of foul-brood, it may be mentioned that Aristotle mentions some bee-disorders in his works on husbandry, and it is quite likely that he was familiar with this disease. Schirach seems to have known it well, for in his "History of Bees" (1769) he gave it the name of "foul-brood" ("Bacteria of the Apiary"). It has occupied the attention of a number of investigators at different times, with the view of discovering its cause and cure, but hitherto with comparatively small results, though some headway has been made of late in checking and curing it by careful treatment. It is quite possible that the disease was not so troublesome in former times as now, as the facilities for its spreading were few compared with what they have been during the last thirty years. The trade in bees and queens that has accompanied the expansion of modern bee-culture, and their consequent transportation from district to district and from country to country, is accountable, no doubt, for the universal extent of its ravages at the present time.

Current Investigations.

In addition to the bacteriological researches into bee-diseases that have been going on in America for some time past, and of which a report, entitled "The Bacteria of the Apiary," has been published, others of a like nature have been conducted by Dr. Maassen, of the Imperial Biological Institute, Dahlen, Prussia. An epitome of his report appeared in the *British Bee Journal* for the 30th April and the 7th May, 1908.

Both reports are interesting and valuable additions to the literature on the subject, any differences of opinion that may exist as the result of these separate investigations appear to be chiefly concerning the special organisms found in foul-brood, and their actions at different stages.*

At present we need not concern ourselves with this matter, it is sufficient to describe the symptoms of the disease met with throughout the Dominion, and the remedy we have found to be the most efficacious.

Foul-brood in New Zealand.

When or where it first made its appearance in this country is not known so far as I am aware, but I do know that foul-brood was very prevalent in some districts—notably in Taranaki, Hawke's Bay, and Poverty Bay—

* A summary of Dr. Maassen's report will be found on another page.

before 1880. For several years subsequent to this date there was a great rush into beekeeping, accompanied by a rapid spreading of disease, till in 1888 I do not think there was any part of the Dominion entirely free from it. This, it is almost needless to say, had a disastrous effect on the industry —large numbers giving it up. Commercial beekeeping from that time remained more or less inactive until the Department of Agriculture took it up and gave it support. This at once put new life into the industry, with the result that it is rapidly developing into a very important one, and with the very efficient Apiaries Act now in force it is expected that foul-brood, which has been the greatest drawback to the industry in the past, will be brought under control.

Report on Specimens of Diseased Combs.

In June, 1907, I received a request from Dr. E. F. Phillips, in charge of Apiculture, United States of America, to forward him specimens of New Zealand diseased combs for examination. Six specimens were sent in the following August, three obtained from Southland, and three from Auckland Province. They were typical specimens of the disease existing throughout the Dominion. Subsequently I received the following report upon them, dated from Washington, D.C., 23rd November, 1907, and for which I thank Dr. Phillips :—

The six specimens of diseased brood which you sent, August 2nd, were received, and I wish to make the following report on them : All these samples showed the gross characters of American foul-brood, and all of them have been examined bacteriologically. *Bacillus larvæ* was found in the scales of each, confirming the original diagnosis. You will be interested in knowing that in carrying out our experiments on this disease we have used, among others, a pure culture of *Bacillus larvæ* isolated from each of the samples you sent. Cultures of *Bacillus larvæ* from your samples have the same cultural characters as those isolated from samples obtained here. Some of these cultures from your samples were fed to colonies, as described in Circular No. 94 of this Bureau, with the result that the disease was produced as described in this publication. You are then able to say distinctly that American foul-brood exists in New Zealand, and that it is caused by *Bacillus larvæ.*

State Legislation.

The economic value of the bee-farming industry is now recognised in all progressive countries, and is receiving encouragement in some form in most of them. The knowledge of losses sustained in the past through disease, which to a large extent is preventable, and curable in its early stages, has caused an energetic movement in the direction of stamping it out, or, at all events, in bringing it under control.

New Zealand stands foremost in this respect, for there is no Apiaries Act in existence at the present time so efficient for dealing with foul-brood as our own. This is recognised by beekeepers in other countries as well

as those in New Zealand, for congratulations have been received from England, America, and Australia—Dr. E. F. Phillips said in one of his letters after reading our Act, "I wish we had such an Act here."

In carrying out the provisions of the Act every assistance and courtesy has been received from the owners of apiaries, even from those where we have been compelled to take extreme measures and destroy box hives and their contents owing to their being badly diseased. There is a general readiness to comply with the Act when the particulars are explained.

Symptoms of Foul-brood.

As I have already said, we need not at present concern ourselves about the distinction of germs causing disease, so long as we know and can detect the symptoms of the form of foul-brood we are troubled with, and these generally support the statement of Dr. Phillips that we have the so-called "American," or ropy, foul-brood.

Healthy brood in the larva stage—that is, before it is sealed or capped—presents a clear pearly whiteness, but when attacked, which is usually, as Dr. Phillips remarks, "about the time of capping," changes to a light buff, then to brown. It is, however, when the brood has been capped that the novice is better able to detect the presence of disease.

In the early stage of an attack a capped cell here and there appears somewhat different from the surrounding healthy brood. Instead of the cappings or seals being bright, full, and of convex form, characteristic of healthy brood, they are of a dull blackish-brown colour, and flat or sunken (see Plate XVII), an indication that the cells contain dead pupæ. The disease rapidly spreads to surrounding cells and combs, if allowed to take its course, till finally no brood can hatch, and the colony succumbs. On opening some of the cells a thin glue-like coffee-coloured mass will be noticed, which on the insertion of a splinter of wood adheres to the point, and can be drawn rope-like for some little distance out of the cells. This is one of the most distinctive features of foul-brood prevalent in New Zealand, and where present is considered conclusive evidence of the disease. Later on this glue-like substance dries up into the before-mentioned black scale-like body.

Other symptoms are "pin-holes" and ragged perforations in the cappings of the cells, clearly shown in Plate XVIII, and a very disagreeable smell resembling that of heated glue or tainted meat, which may be sometimes, though rarely, detected at some yards away from a badly infected hive in close weather. The characteristic odour cannot easily be detected in the earliest stages, even when an infected comb is placed close to the nose, but some slight difference can be noticed between that and healthy comb at all times.

Symptoms of "European" Foul-brood.

It will be well to make known here the symptoms of this form of foul-brood, as described by Dr. E. F. Phillips, in Circular No. 79, Bureau of Entomology, Washington, D.C.

Adult bees in infected colonies are not very active, but do succeed in cleaning out some of the dried scales. This disease attacks larvæ earlier

than does American foul-brood (*Bacillus larvæ*), and a comparatively small percentage of the diseased brood is ever capped; the diseased larvæ which are capped over have sunken and perforated cappings. The larvæ when first attacked show a small yellow spot on the body near the head, and move uneasily in the cell; when death occurs they turn yellow, then brown, and finally almost black. Decaying larvæ which have died of this disease do not usually stretch out in a long thread when a small stick is inserted and slowly removed; but occasionally there is a very slight "ropiness," but this is never very marked. The thoroughly dried larvæ form irregular scales which are not strongly adherent to the lower side wall of the cell. There is very little odour from decaying larvæ which have died from this disease, and when an odour is noticeable it is not the "glue-pot" odour of American foul-brood, but more nearly resembles that of soured dead brood. This disease attacks drone and queen larvæ very soon after the colony is infected. It is, as a rule, much more infectious than American foul-brood and spreads more rapidly. On the other hand, it sometimes occurs that the disease will disappear of its own accord, a thing which the author never knew to occur in a genuine case of American foul-brood. European foul-brood is most destructive during the spring and early summer, often almost disappearing in late summer and autumn.

Caution to those importing Bees and Queens.

It is now generally understood that disease ("foul-brood" and "black-brood") may readily be conveyed from one country to another through the food supplied to the queens and bees, be it honey in combs or the usual "candy," with which the queen-cages are furnished. The latter is made with sugar and some honey, and as it is through germ-infected honey that disease is generally conveyed, it is absolutely necessary that every precaution should be taken against risk, lest we inadvertently import the dreaded "black-brood."

The measures to be taken to avoid risk are simple. With queens everything except the queens themselves, including the bees accompanying them, should be burned after the queen has been put into a clean introducing-cage. In the case of colonies, the comb and frames should be burned, and the bees be treated at once on the McEvoy plan as follows:—

Treatment of Foul-brood.

Time and experience have so convincingly proved that treatment by drugs (so prominent at one time) utterly failed to make any inroads on the disease that it would be waste of time to discuss the matter here. We have in the McEvoy treatment, when properly carried out, an effective cure, which has already been tried and proved in probably thousands of cases in New Zealand, and that is the one I advocate.

Where the disease is so far advanced as to have left few bees in the colony, then it will be safest to destroy everything that has been in contact with it by fire. "Tinkering" with such a colony would be both useless and dangerous.

Treatment may be successfully undertaken at any time when honey is being freely stored. When going through the hives in spring make a note of those showing signs of diseased combs (which are readily detected at that time), for treatment later on, and be very careful that robbing is not started. When the honey season has set in, keeping the bees busy, treatment should begin. All operations in this connection should be carried out in the evening, when the bees are quiet.

Prepare a clean hive and bottom board with narrow starters of comb-foundation in the frames. Remove the infected hive and stand to one side, and put the prepared one in its place, prop up the front about an inch, lay a sack near the entrance, and shake and brush the bees as quietly as possible close to the entrance, and when finished remove every vestige of the infected hive away where bees cannot get at it. The combs, if not too badly infected, may be melted into wax, or, if insufficient in quantity for that purpose, they, with their frames, had better be burned right away and the ashes buried. The hive, bottom board, and cover, if sound and worth saving, should be cleaned and thoroughly disinfected with a strong solution of carbolic acid or izal, or singed inside by fire.

On the evening of the fourth day following, the necessary number of frames for the hive should be furnished with full sheets of comb-foundation, to be exchanged with those the bees have been working on. This can be done by removing the frames one at a time, shaking the bees back into the hive, and inserting the others. The comb built on the starters during the four days may be cut out and melted up, and the frames disinfected.

The theory of this treatment is that during their four days' comb-building the bees use up all the infected honey contained in their honey-sacs when taken from their old hive, so that when shifted again at the end of the four days they start clean.

Feeding and Disinfecting.

In all cases when treatment is going on and honey is not being stored freely, feed sugar-syrup liberally after shifting the bees on the fourth day. Mix half a pint of water with each pound of sugar used, stir well, and bring it to the boil; when cool it is ready. Always feed within the hive and in the evening.

Be sure to remove out of the way of the bees, and disinfect or burn, everything used during the operations of treatment; and a solution of izal should be kept for disinfecting the hands, knives, &c., after handling an infected colony. Directions are given on the bottles, and the solution will not harm the skin. Also dig the ground over around the diseased-hive stand.

After-inspection.

In from three to four weeks, when the new brood begins to emerge, keep a look-out for any suspicious-looking brood-cells, and if any are seen

cut them out at once, together with the adjoining cells. If suspicious cells recur treat again fully. "Eternal vigilance" should be the watchword of every beekeeper who hopes to keep down disease.

To prevent Swarming out.

On rare occasions colonies swarm out during treatment, but this is not likely to occur when honey is being gathered freely. It can be guarded against by caging the queen for a few days, or by giving a wide entrance and placing queen-excluding zinc across.

Saving Healthy Brood.

When several colonies are to be treated and there is a large quantity of healthy brood in the combs, put a queen-excluding zinc honey-board over the frames of one of the least-affected hives, and put all the healthy brood above this to emerge. When this has been accomplished remove everything and treat the colony in the manner advised. The zinc prevents the queen making use of the affected combs while the brood is emerging.

Autumn Treatment.

When it is desired to treat colonies in the autumn *after brood-rearing has ceased*, just put the bees into clean hives provided with ample winter stores in the shape of frames of honey from *clean* colonies. The disease is not likely to reappear.

Young Queens.

There can be little doubt that bees from young vigorous queens can better cope with disease than those bred from aged and weak mothers. It is therefore advisable to change the queens at the time of or shortly after treatment if those in the affected hives are not up to the mark; in any case it is profitable to do so if young queens can be obtained.

Summary of Dr. Maassen's Report.

The following is the summary as published in the *British Bee Journal* for the 7th May, 1908:—

To sum up Dr. Maassen's important work, we find,—

1. That three different organisms may produce foul-brood, two of which are usually associated in different phases of the disease. These are *Bacillus alvei*, Cheshire; *Bacillus Brandenburgiensis*, Mausen (syn. *B. Burri*, Burri, *B. larvæ*, White); *Streptococcus apis*, Mausen (syn. *B. Guntheri*, Burri).

2. That when the disease attacks unsealed larvæ *B. alvei* is present, and in virulent cases it is also found in sealed brood.

3. That *Streptococcus apis* of "sour-brood" is usually associated with *B. alvei*.

4. That *B. Brandenburgiensis* is found in the sealed larva only just before it changes to a pupa, and is frequently associated with *B. alvei*.

5. That the two bacilli are antagonistic to each other, and are constantly struggling for supremacy, sometimes the one and sometimes the other getting the upper hand.

6. That other bacteria are sometimes associated with *Streptococcus apis* which kill its cocci, so that bees are able to remove the dead larvæ, and in some instances during a good honey-flow the disease may be held in check or the colony become for a time cured.

7. That the disease in which either or both bacilli are present is equally infectious.

The Power of Resistance in Spores of Bacillus Larvæ.

In Bulletin No. 75, Part IV, just issued by the United States Department of Agriculture, the author, G. F. White, Ph.D., expert in bacteriology, says, "The spores of this bacillus (*Bacillus larvæ*) are very resistant to heat and other disinfectants. They resist the boiling-temperature of water for fifteen minutes. In 5 per cent. of carbolic acid they were not killed in two months' time. Likewise it has been demonstrated that the spores of *Bacillus larvæ*, when taken from the scales of American foul-brood, resist the action of mercuric chloride (corrosive sublimate), 1 : 1,000 aqueous solution, for two months. Having such facts before us, we can better judge he methods for treatment."

OTHER DISEASES.

The following description of symptoms of other diseases than foul-brood, and which so far have given but very little trouble in New Zealand, is taken partly from "The Bacteria of the Apiary," published in 1906 by the United States Department of Agriculture, and partly from "The Brood Diseases of Bees," by Dr. E. F. Phillips, of the same Department:—

Pickle-brood.

There is a diseased condition of the brood called by beekeepers "pickle-brood," but practically nothing is known of its cause. It is characterized by a swollen watery appearance of the larvæ, usually accompanied by black colour of the head. The larvæ usually lie on their backs in the cell, and the head points upward. The colour gradually changes from light yellow to brown after the larva dies. There is no ropiness, and the only odour is that of sour decaying matter, not at all like that of American foul-brood. In case the larvæ are capped over, the cappings do not become dark, as in the case of the contagious diseases, but they may be punctured. So far no cause can be given for this disease, and whether or not it is contagious is a disputed point. Usually no treatment is necessary beyond feeding during a dearth of honey, but in very rare cases when the majority of larvæ in a comb are dead from this cause the frame should be removed and a clean comb put in its place, to make it unnecessary for the bees to clean out so much dead brood.

Chilled, Overheated, and Starved Brood.

Many different external factors may cause brood to die. Such dead brood is frequently mistaken, by persons unfamiliar with the brood diseases,

for one or the other of them. Careful examination will soon determine whether dead brood is the result of disease or merely some outside change. If brood dies from chilling or some other such cause, it is usually soon carried out by the workers, and the trouble disappears. No treatment is necessary. Brood which dies from external causes often produces a strong odour in the colony, but wholly unlike that of American foul-brood—merely that of decaying matter. The colour of such brood varies, but the characteristic colours of the infectious diseases are usually absent, the ordinary colour of dead brood being more nearly grey.

Palsy or Paralysis.

The disease known to apiarists as palsy ar paralysis attacks adult bees. The name is suggestive of the symptoms manifested by the diseased bees. A number of bees affected were received from apiaries in New York State in 1903; bacteriological examinations were made, and several species of bacteria were isolated and some experimental inoculations made, but no conclusions as to the cause of this disorder could be drawn from the results obtained.

From a study of the normal flora of the bee it was soon found that there were quite a number of species of bacteria present. This fact stimulated a study of the normal flora. . . . From this point the work can be carried on with the hope that if the disease has a bacterium as an etiological factor it may be found.

This disease sometimes, though rarely, makes its appearance in New Zealand. Some years ago I was consulted about a severe case that occurred in an apiary in the Nelson District, where a number of colonies were affected, and the owner had tried several remedies. I suggested sprinkling the bees with finely powdered sulphur, having seen it recommended in one of the American bee journals a short time before: the owner of the bees tried this, and subsequently reported that it had effected a complete cure.

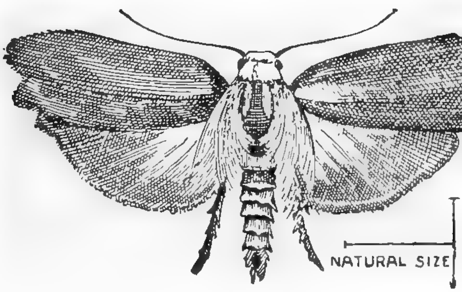
It is said that the disease is never transmitted by the brood or combs; the brood can, therefore, be taken away and given to other colonies without risk so long as no dead bees are transferred with them; the bees can then be treated by themselves. It would no doubt be safer where there were only one or two colonies attacked to smother the old bees after removing the brood, and thoroughly disinfect the hive.

VII. THE LARGE BEE OR WAX MOTH (*Galleria mellonella*, Linn.).

The first intimation of this moth's presence in New Zealand was when Messrs. H. Betts and Son, of Okaiawa, near Mount Egmont, in the early part of 1904, sent me some larvæ or grubs found in their hives, and which were strange to them. I had no difficulty in recognising them as the grubs

of the large wax-moth, having seen them previously in boxes of bees imported from Italy. It is quite likely the eggs or grubs of the moth may have reached here from Australia with bees, as it is known that the moth has been plentiful there for more than a quarter of a century.

When going through the Egmont district in March, 1905, I discovered the moths in three different apiaries a considerable distance apart, showing that they were spreading. I have since had grubs sent me from the Patea district. A beekeeper in the former district, who had trouble with the moth when he commenced beekeeping and has since taken great interest in the matter, recently informed me that he had seen it in a good number of apiaries, but that it only causes trouble " in the cases of careless beekeepers, and where bees are kept in old box hives."



LARGER BEE-MOTH.

WHERE THE GRUBS MAY BE FOUND.

A favourite haunt of the grubs is on the top of the frames under the mat, or where there are two mats they will get in between them. In the daytime they apparently hide from the bees, and at night attack the combs; but when the colony becomes very weak the grubs show no such fear, and attack the combs at all times.

It is the larvæ or grubs of the moth which prove so destructive to the combs, burrowing through them under the protection of strong silken galleries which they spin round themselves, secure from the bees, as they advance in their work of destruction. Eventually the combs are completely destroyed, and fall, a mass of web and cocoons, to the bottom of the hive (see Plate XIX).

HABITS AND NATURAL HISTORY

The moth itself, which is usually to be seen during warm summer evenings flitting about the hives, watching for an opportunity to lay its eggs within or near the entrances, can readily discover weak colonies, when it does not hesitate to enter the hives, and thus the grubs eventually get a footing, from which they are seldom or never dislodged by the bees.

The late Mr. Sidney Oliff, when Government Entomologist for New South Wales, in an article on the natural history of this moth, said,—

With us in New South Wales the first brood of moth appears in the early spring, from caterpillars which have passed the winter in a semi-dormant condition within the walls of their silken coverings, and only turned to pupæ or chrysalids upon the approach of warm weather. These winter (or hibernating) caterpillars feed very little, and usually confine their wanderings to the silken channels which they have made for themselves before the cool weather sets in. Upon the return of the desired warmth the caterpillars spin a complete cocoon for themselves and turn to the chrysalis stage, and in from ten days to a fortnight the perfect moth appears. The moth then lays its eggs in any convenient spot, such as the sides and bottoms of the frames, on the walls of the hive itself, or on the comb. In each case I have had an opportunity of observing the process, the moth chose the sides of the frames, as near to the brood combs as possible, the young larvæ having decided preference for this comb. The larvæ having once made their appearance, which they usually do in from eight to ten days after the laying of the eggs, their growth is exceedingly rapid, the average time before they are ready to assume the chrysalis stage being only some thirty days. The average duration of the chrysalis period is about a fortnight, so it can easily be seen with what great capabilities for rapid reproduction we have to deal. As we have said, the number of generations, or broods, which develop in a season—*i.e.*, between early spring and late autumn—varies with locality and climate; but it may be worth while to record that, in my opinion, we have sufficient evidence to prove the existence of four broods in the Sydney district under ordinary circumstances.

The average length of the grub is about 1 in., and "when first hatched it is pale yellow with a slightly darker head, and of a greyish flesh-colour when full-grown, with a dark reddish-brown head." The length of the moth is about ¾ in., "has reddish brown-grey forewings, which are distinctly lighter in colour towards the outer or hinder margins."

The Remedy.

That wax-moths, large and small, are only enemies of careless beekeepers and of those who have not advanced beyond the common box-hive stage is a well-known fact. Careful, up-to-date beekeepers have nothing to fear from these or any other insect enemies. Follow the golden rule of beekeeping—viz., "Keep all colonies strong"—and insect enemies will never trouble.

Fumigating Combs.

Not only the combs within the hives, but also any which may happen to be unprotected, are liable to be attacked by the moth. No combs or pieces of combs should be allowed to lie about; when they are of no further service they should be melted into wax at once. Spare combs should always be stored in a place of safety from the moth, and inspected frequently. On the first sign of moths or grubs they should be fumigated, and a few days afterwards they should undergo a second fumigation. When there are

not many to do they may be suspended in empty hives about 1 in. apart, and the latter piled one on the other, taking care that the junctions of the boxes are made smoke-tight by pasting a strip of paper round them. The top box of the pile should contain no frames. Into this place an old iron saucepan containing live wood-embers, and on to these throw a couple of handfuls of sulphur, close the cover securely, and keep closed for a couple of days. In a large apiary it is best to have a small room fitted up for the purpose. Two or three pounds of sulphur will be sufficient for a large room.

THE APIARIES ACT.

The following is a digest of the Apiaries Act which came into force on the 14th September, 1907 :—

INTERPRETATION.

2. In this Act, if not inconsistent with the context,—

" Apiary " means any place where bees are kept :

" Beekeeper " means any person who keeps bees or allows the same to be kept upon any land occupied by him :

" Disease " means foul-brood (*Bacillus alvei* and *Bacillus larvæ*), bee-moths (*Galleria mellonella* and *Achræa grizella*), and any other diseases or pests from time to time declared by the Governor in Council to be diseases within the meaning of this Act :

" Frame hive " means a hive containing movable frames in which the combs are built, and which may be readily removed from the hive for examination :

" Inspector " means any person appointed by the Governor as an Inspector under this Act.

BEEKEEPER TO GIVE NOTICE OF DISEASE.

3. Every beekeeper in whose apiary any disease appears shall, within seven days after first becoming aware of its presence, send written notice thereof to the Secretary for Agriculture, at Wellington, or to any Inspector of Stock.

POWERS OF INSPECTORS.

5. Any Inspector may enter upon any premises or buildings for the purpose of examining any bees, hives, or bee appliances, and if the same are found to be infected with disease he shall direct the beekeeper to forthwith take such measures as may be necessary to cure the disease ; or, if in the opinion of the Inspector the disease is too fully developed to be cured, he may direct the beekeeper within a specified time to destroy by fire the bees, hives, and appliances so infected, or such portions thereof as the Inspector deems necessary.

Removal of Bees to New Hives.

6. In any case in which it is found by an Inspector that the bee-combs in any hive cannot, without cutting, be separately and readily removed from the hive for examination, he may direct the beekeeper to transfer the bees to a new frame hive within a specified time.

Inspector's Directions to be obeyed.

7. (1.) Every direction by an Inspector shall be in writing under his hand, and shall be either delivered to the beekeeper personally or sent to him by registered letter addressed to him at his last-known place of abode.

(2.) Every such direction shall be faithfully complied with by the beekeeper to whom it is addressed, and, in default of compliance within the time specified, the Inspector may within one month destroy or cause to be destroyed by fire, at the expense of the beekeeper, any bees, hives, and appliances found to be infected with disease.

Infected Bees, etc., not to be kept or sold.

8. No beekeeper shall—

(*a.*) Keep or allow to be kept upon any land occupied by him any bees, bee-combs, hives, or appliances known by him to be infected by disease without immediately taking the proper steps to cure the disease ; or

(*b.*) Sell, barter, or give away any bees or appliances from an apiary known by him to be infected by disease.

Frame Hives to be used.

9. No beekeeper shall, after the expiry of six months from the passing of this Act, keep or knowingly allow to be kept on any land occupied by him any bees except in a properly constructed frame hive.

Offences.

10. Every person is liable to a fine not exceeding five pounds who—

(*a.*) Obstructs an Inspector in the exercise of his duties under this Act, or refuses to destroy or to permit the destruction of infected bees or appliances :

(*b.*) Fails to comply with any direction given under the provisions of this Act by any Inspector :

(*c.*) Commits any other breach of this Act.

PART III.—BEES IN RELATION TO FLOWERS AND FRUIT-CULTURE.

I. IN RELATION TO FLOWERS GENERALLY.

THE primary object of this chapter is to bring under the notice of our orchardists and others interested in fruit-growing the immense value of the cross-fertilisation of fruit-blossoms in the production of fruit, and to show the important part the hive-bee plays in bringing this about. In order the better to realise the complex mechanism of flowers and the wonderful process of fertilisation, and so to appreciate the effects of cross-fertilisation in the orchard, I deem it necessary to touch upon these points before dealing directly with the main subject.

Insect-life and plant-life are almost entirely interdependent upon each other. Insects obtain sustenance and, in the majority of cases, shelter from the vegetable world, while plants of most kinds are mainly dependent upon insects for the propagation of their species. A host of insects, large and small, of which the hive-bee is the most important, feed chiefly on the saccharine matter secreted in the nectaries of blossoms; and some of them (the hive-bee in particular) require for their own food or for that of their young a good deal of farinaceous matter supplied by the fecundating dust of the anthers of the same blossoms, termed "pollen." On the other hand, it is necessary for the proper fertilisation of the plant that such fecundating dust brought from some other plant of the same species should come in contact with its pistils, and this is effected by the agency of insects chiefly.

SEXUAL ORGANS IN FLOWERS.

In flowers there are organs analogous to, though widely differing from, those indicative of sex in the animal kingdom. The functions at least are the same; and the combined action of the two sets is essential to the propagation of the race by seed.

In this connection it is interesting to note the remarks of the late F. R. Cheshire. He said,—

Blooms are produced by plants in order that seeds may follow, and so the race be continued. Two parts are essential to this reproduction—the anther and the pistil, the latter very generally occupying the central posi-

tion. The anther is usually a double-celled pouch, the contents of which by segmentation break up into a number of perfectly similar parts called "pollen-grains," which though minute are complex in structure. When these are mature the anther splits or dehisces (to open) and the pollen escapes, but it needs in some way to be applied to the termination of the pistil, called the "stigma." When this application is effected, the pollen-grain absorbs moisture, its interior portion swells, and actually throws out a tube which often grows to a great length in making its way towards the unimpregnated nucleus of the ovule, which is situated in the ovary at the base of the pistil. In this nucleus a large cavity filled with protoplasm has developed, called the "mother-cell," within which we find the embryonal vesicle to which the contents of the pollen-grain is transferred by the channel of the pollen-tube. This is fertilisation, and upon it depends the production of seed, for the new individual plant has its beginnings from this interfusion.

Most flowers are hermaphrodite, or double-sexed—they contain both the stamens (anther-bearers) and pistils within the same calyx or on the same receptacle; but there are some species where the sexual organs, male and female, are found on different individual plants, so that some agency for the transference of the fructifying pollen-grains is absolutely necessary, or the species would soon die out. Many of the latter are anemophilous (wind-fertilising plants), with inconspicuous flowers yielding no nectar, therefore not attractive to insects. In these cases nature provides the male blossoms with an abundance of pollen-grains, which are wafted by the wind to considerable distances, and so are likely to reach female blossoms and fulfil their all-needful function.

MECHANISM OF FLOWERS.

Darwin and others have proved that "cross-fertilisation is a most important factor in the continued vitality of any species of plant, and gives an enormous advantage in the struggle for existence where the conditions of life are not wholly favourable." In the hermaphrodite or double-sex flowers, where self-fertilisation is possible, Nature has provided in most cases some wonderful contrivances to prevent it, and to insure cross-fertilisation by the transference of the all-potent pollen-grains from some other plant of the same species.

The adaptability of the hive-bee to the work of cross-fertilisation seems most marvellous, when we realise that in its separate expeditions in search of nectar and pollen it keeps to the flowers of the same species, otherwise its visits would be of no service in most cases, and probably detrimental in many.

On the subject of hermaphrodite flowers, Cheshire says,—

An examination of most blooms will show that the essential organs before referred to (anthers and pistils) are so placed that an accidental or unaided transfer of pollen to stigma is unlikely, and where this arrangement of parts is not found it frequently occurs that the anthers ripen and dehisce much

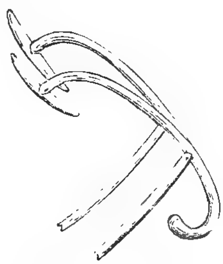
before, or not until some time after, the stigma has so matured as to be ready for pollination. In the former case, as we may observe in the common garden nasturtium (*Tropæolum majus*), the pollen is all carried away by insects by the time the stigma presents itself, so that if fertilisation be effected it must be through the bringing of pollen from some other blooms still shedding it. Insects are the means which accomplish this, and to secure their visits the blooms spread them a banquet.

The wonderful mechanism developed by double-sex flowers to insure their cross-fertilisation is shown in the following familiar and interesting illustrations.

Salvia officinalis. Young Flower visited by a Bee.

In the common sage (*Salvia officinalis*) both the stamens and the pistil are of a very peculiar form, and the latter is not fully developed and ready to be fecundated until *after* the anthers of the same blossom have shed their pollen. The shape of the flower, and the mode in which the bee enters it, are shown in the above figure, in which the tip of the still undeveloped pistil is seen just over the back of the bee, which is forcing its way down to the nectary through the stamens—not visible.

The anthers are shown in the next figure, but on an enlarged scale.



Stamens and Anthers.

The anther-cells, instead of being close together, are at the two ends of a long connective, which is attached by a sort of pivot joint at about one-third of its length to the stalk of the stamen. The lower anther-cells contain very little pollen, sometimes none at all, while the upper ones are fully developed as shown in the figure. When the bee thrusts its head into the tube, it presses against the lower cells and pushes them back; the connectives revolve on their axis, and the upper anther-cells are brought down on the bee's back, the hairs of which brush off the pollen, which the

bee carries away, and as soon as it meets with an older blossom, in which the pistil is fully developed, as seen in the next figure, it is evident that

Salvia officinalis. Older Flower, with Pistil developed.

upon entering the tube of this blossom the pollen already on the bee's back must be rubbed against the stigma, and the cross-fertilisation be thus effected.

II. IN RELATION TO FRUIT-CULTURE.

Professor A. J. Cook, the well-known American entomologist and apiarist, author of "The Manual of the Apiary," formerly of Michigan Agricultural College, and now of Pomona College, California, who has paid particular attention to this subject, extending over a long period, wrote me a short time ago in reply to some questions I sent him. He said,—

Bees never harm blossoms, but are always a help. Bees are a tremendous aid through pollination. Many of our best fruits must be cross-pollinated to produce. Many pears, apples, and plums, &c., are utterly sterile to their own pollen. Bees are alone numerous enough to effect this valuable service. I am sure that it is an incontrovertible fact that bees as the great agents in pollination are far more valuable to the world than for the honey they produce. The best orchardists (in California) now arrange with apiarists to bring their bees to the orchards; they find they must have the bees.

Coming from such an authority, this is eminent testimony as to the value of the hive-bee to orchardists.

Conclusive evidence in this respect came under my own observation. In the winter of 1882 I started a bee-farm at Matamata, and had about one hundred colonies of bees when the fruit-blooming season came on. The apiary was located close to a mixed orchard of large trees, covering some 10 acres. The nearest bush was about five miles distant, and, the orchard being in an open plain, there was no shelter for wild bees nearer than the bush, so that it is not at all likely the orchard was visited by many bees. I was informed that, though the trees blossomed abundantly each season, the trees bore very little fruit, that the whole 10 acres did not supply fruit enough for the station. The result in that and subsequent seasons, by the aid of my bees, was that the trees had to be propped up in all directions to keep them from breaking down under the weight of fruit.

Mr. R. T. Morrison, of Messrs. E. Morrison and Sons, Warkworth, well-known horticulturists, supply the following interesting note regarding cross-pollinating experiments which have been carried out at their orchards :—

Three seasons ago a small pear-tree was selected for operations. When the blossom-buds were in the right condition—namely, when the petals of a large proportion of the blossoms were almost ready to break open—the blossoms and blossom-buds were thinned out to, roughly speaking, about one-sixth of what the tree originally held, leaving only such as would open into full flower in about a day or two. These petals (all being of unopened blossoms), together with stamens and in some instances calyx also, were then removed, and the tree was covered with butter-cloth. In a few days pollen of another variety of pear was administered to the stigmas, being placed there by hand and not shaken on, and the tree was again left covered with butter-cloth. This pear-tree set and matured a large crop of fruit—in fact, too large—while other trees of the same variety alongside set practically nothing.

Two seasons later (that is in 1905) this same tree was treated in the same manner, except that blossoms were thinned down to about one-tenth ; butter-cloth or other covering was not used ; and pollen from another variety (that is a different variety from that from which pollen was taken for the previous experiment) was made use of. Though no covering was used it would appear that the bees would not be likely to much visit a tree from which the petals had been entirely removed. Still, almost every blossom that was treated seemed to set, and the result was a crop much too heavy. Other trees of the same variety alongside had a fair crop, but not nearly so heavy as this one.

Other experiments with various fruits have been carried out at different times with varying success. The above two instances are perhaps the most striking.

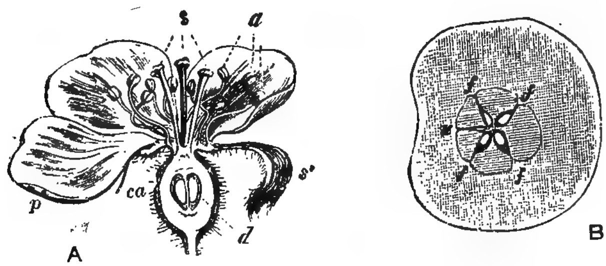
I may mention that bees are very busy agents in our orchards during the blossoming season, when the weather is fine enough. Still, it would be too much to expect that the bees would always be able to carry the right pollen to the right trees at the right time. But no doubt the bees would be even of much more value in the orchard than they are at present if we had the knowledge as to which varieties of a fruit were best for fertilising other varieties, and were to lay off our orchards in such a way as to give the bees the best opportunity of carrying pollen from one variety to the other.

Mr. Morrison has since carried out a further series of experiments, and for the purpose of insuring cross-fertilisation where it had partially failed before, has grafted on some of his fruit-trees scions of particular varieties which will bear suitable pollen for the purpose.

An eminent authority, when speaking of the fertilisation of apple-blossoms, said,—

The apple is called by botanists a pseudo-syncarpous fruit, because it may be regarded as five fruits gathered into a unit by an envelope formed by a development of the calyx. If an apple be cut across we see five compartments or dissepiments in the core (see Fig. B), each one of which should contain pips or seeds. The bloom which preceded the fruit had five stigmas (see Fig. A), three of which are shown in section, and each one of which com-

municated with a dissepiment or partition, and required an independent fertilisation. Bees seeking honey would, by getting their breasts (furnished as they are with abundance of long webbed hairs) thoroughly dusted with apple-pollen, and flitting to a bloom whose stigma had reached the receptive condition, bring about fertilisation. It would, however, frequently



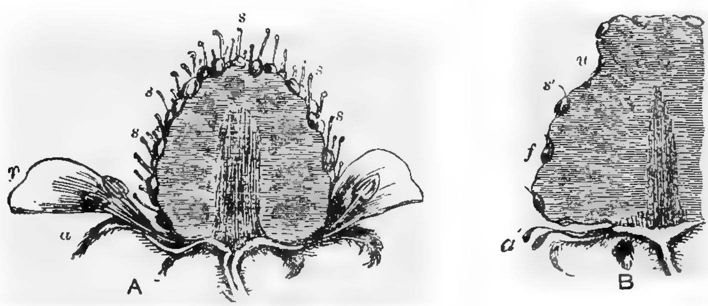
Section of Apple (*Pyrus malus*) A—Blossom; B—Fruit.

happen that three or four of the stigmata only would be pollinated. In this case an apple, though an imperfect one (see Fig. B) would be produced. Trees agitated by the winds frequently drop a number of their fruits, hence known as "windfalls," but the actual cause of this dropping is in by far the largest number of instances defective fertilisation.

The well-known author of "Bees and Beekeeping" says (Vol. i, page 323),—

I had two hundred apples, that had dropped during a gale, gathered promiscuously for a lecture illustration, and the cause of falling in every case but eight was traceable to imperfect fertilisation. Such fruits are readily recognised by being deformed, a part failing to grow (see Fig. B) from the want of perfect fertilisation. Cutting one such apple across, no seed will be found opposite the undeveloped part. These facts taken together show conclusively how completely our fruit-crop is dependent upon insect agencies, and amongst these the hive-bee takes the most important place.

In the case of the strawberry—and the same applies to the raspberry and other berry fruits—each little achenia (popularly known as seed) dotting its surface possesses a style and stigma (see Fig. A). The stigma of each



Section of Full-grown Strawberry, partially fertilised, showing Undeveloped Portion.

of the achenia must be fertilised to produce a perfect fruit; otherwise, if this is but partially accomplished, the part unfertilised remains undeveloped—hard, shrunken, and green—when the fertilised portion is fully ripe (see Fig. B). Almost any dish of strawberries will furnish such examples.

When we consider that, according to Cheshire, it requires from 100 to 200, or even 300, distinct fertilisations to produce a perfect strawberry, we can realise how necessary it is to have the agents for such fertilisation near at hand when the plants are in blossom. Gooseberries are absolutely dependent on insects, and in fact all fruits are dependent upon outside agencies for their growth and development.

It is well to note here a statement in Cheshire's work that I have not noticed elsewhere, viz.:—

There is a tendency to a separation of the sexes in the cultivated strawberry, which Darwin observes "is far more strongly marked in the United States than in Europe"; and growers will do well to note that plants bearing unusually large blossoms are frequently tending to become male, and produce few fruits, while those of the same variety and under the same treatment that produce small blossoms are tending to become female, and are abundant bearers, while they yield few runners. Without care in selecting, the numerous runners of the former would ultimately supplant the female forms, and so ruin the stock for economic purposes.

When lecturing to some of the largest growers of strawberries in the United Kingdom, Mr. Cheshire found them all quite unaware of the above tendency. New Zealand growers are not, I should imagine, ignorant of a fact of so much importance to their success, but I think it well to quote the paragraph.

I may also quote the following authorities:—

Professor L. O. Howard, Chief of the Division of Entomology, Department of Agriculture, United States of America, in his introduction to Bulletin No. 1 on "The Honey-bee," third edition, issued in 1899, says of bees and bee-culture,—

This branch of agricultural industry does not impoverish the soil in the least, but, on the contrary, results in better seed and fruit crops. The total money gain to the country from the prosecution of this industry would undoubtedly be placed at several times the amount given in the table above ($20,000,000) were we only able to estimate in dollars and cents the result of the work of bees in cross-fertilising the blossoms of fruit-crops. In support of this it is only necessary to refer to the fact that recent investigations of another Division of this Department have shown that certain varieties of pear are nearly or quite sterile unless bees bring pollen from other distinct varieties for their complete cross-fertilisation.

Professor Baily, Horticulturist of Cornell University, says,—

Bees are much more efficient agents of pollination than wind in our fruits, *and their absence is always deleterious.*

"The A B C of Bee-culture" furnishes much evidence of experiments carried out by the Agricultural Department of the United States of America

and by practical fruit-growers, all of which went to prove the value of the hive-bee in the production of fruit, and the loss caused by its absence. One or two instances will suffice. Mr. C. A. Green, writing to the *Fruit-grower*, published in Rochester, New York, said,—

It has now become demonstrated that many kinds of fruits, if not all kinds, are greatly benefited by bees, and that a large portion of our fruit—such as the apple, pear, and particularly the plum—would be barren were it not for the helpful work of the honey-bee. Professor Waite, of the Agricultural Department, Washington, covered the blossoms of pears, apples, and plums with netting, excluding the bees, and found that such protected blossoms of many varieties yielded no fruit. In some varieties there was no exception to this rule, and he was convinced that large orchards of Bartlett (Williams's Bon Chrétien) pears, planted distant from other varieties, would be utterly barren were it not for the work of the bees, and even then they could not be profitably grown unless every third or fourth row was planted to Clapp's Favourite, or some other variety capable of fertilising the blossoms of the Bartlett. In other words, he found that the Bartlett pear could no more fertilise its own blossoms than can the Crescent Strawberry.

And, again, Professor Waite, when speaking of insect-visits to pear-flowers, says,—

The common honey-bee is the most regular, important, and abundant visitor, and probably does more good than any other species;

And sums up as follows:—

Plant mixed orchards, or, at least, avoid solid blocks of one variety. Be *sure* there are sufficient bees in the neighbourhood to visit the blossoms properly. When feasible, endeavour to favour insect-visits by selecting sheltered situations, or by planting windbreaks.

The editor of the *Rural New-Yorker* says,—

In those great greenhouses near Boston, where early cucumbers are grown, it is always necessary to have one or two hives of bees inside to fertilise the flowers. No bees, no cucumbers! unless men go around with a brush and dust the pollen from one flower to another.

Much more evidence as to the value of bees as fertilising agents could be quoted, but the foregoing should be sufficient.

SHELTER.

Well-sheltered orchards with the bees close at hand would receive the most benefit, especially in boisterous weather. The bees could then utilise every hour of sunshine in visiting the blossoms that would be impossible in exposed situations or where the bees had far to fly.

SPRAYING FRUIT-TREES WHILE IN BLOSSOM.

I do not know that it is necessary to say much on this subject, as I dare say our orchardists are well aware that spraying trees with the usual poison-

ous mixtures while in blossom is not only injurious to the blossoms themselves by destroying the pollen, but also poisons the bees which visit them, thus defeating the object every orchardist should keep in view—the cross-fertilisation of the blossoms. In a number of the American States there are laws against doing so.

DO BEES INJURE FRUIT ?

Fortunately, the ignorant prejudice against bees common some years ago amongst viticulturists and other fruit-growers is fast dying out. It was believed at one time in America that bees punctured and destroyed grapes and other delicate fruits, and, notwithstanding that the results of exhaustive experiments conclusively proved the contrary, it took a long time to convince them they were wrong. Bees cannot puncture sound grapes, but during a dearth of honey they will suck the juice from ripe grapes and other fruits *after* they have been punctured by some other animal, or have burst through overripeness. Sound grapes smeared with honey have been put into a hive containing a starving colony of bees: the honey has quickly vanished, but not a grape has been injured. Bunches of sound grapes have been left in four or five hives at a time, directly in contact with the bees, and after three weeks every grape was perfectly intact, but glued to the combs. (See " Langstroth on the Honey-bee," page 507.)

CONCLUSION.

Enough, I think, has been said to convince orchardists, if it were needed, that it is vital to their interests either to keep bees or to see that there are plenty in the neighbourhood of their orchards. It remains only for me to say to those who wish to follow up their investigations on this subject, I would recommend them to read the works of Darwin, Muller, Lord Avebury (Sir John Lubbock), and Cheshire.

I would point out that in New Zealand we have not the number of fertilising insects there are in Europe or America, consequently we are even more dependent on the hive-bees than are orchardists in those quarters of the globe. I think I am correct in saying there are practically no other insects but the hive-bees about in New Zealand when fruit-trees are in blossom. Finally, as a summary, I will quote the conclusions of Herman Muller on the comparative value of bees as fertilisers. He says in his great work on " The Fertilisation of Flowers,"—

Bees, which not only feed on the produce of flowers, but nourish their young also thereon, are in such intimate and lifelong relations with flowers that they show more adaptation to a floral diet, and are more important for the fertilisation of our flowers, and have therefore led to more adaptive modifications in these flowers, than all the foregoing orders (of insects) put

together. . . . Bees, as the most skilful and diligent visitors, have played the chief part in the evolution of flowers; we owe to them the most numerous, the most varied, and most specialised forms. Flowers adapted to bees probably surpass all others together in variety of colour. The most specialised, and especially the gregarious, bees have produced great differentiations in colour, which enable them on their journeys to keep to a single species of flower. While those flowers which are fitted for a miscellaneous lot of short-lipped insects usually exhibit similar colours (especially white or yellow) over a range of several allied species, the most closely allied species growing in the same locality, when adapted for bees, are usually of different colours, and can thereby be recognised at a glance (*e.g.*, Trifolium. Lamium, Tenerium, Pedicularis).

PART IV.—BEES IN RELATION TO AGRICULTURE. *

The benefits derived by both agriculturists and horticulturists from the labours of the bee are now very generally understood and acknowledged; but still cases have sometimes occurred, though rarely, of farmers objecting to the vicinity of an apiary, and complaining of bees as "trespassers," instead of welcoming them as benefactors.

ARE BEES TRESPASSERS?

It is not, perhaps, surprising that at first a man should imagine he was being injured in consequence of bees gathering honey on his land, to be stored up elsewhere, and for the use of other parties; he might argue that the honey belonged by right to him, and even jump at the conclusion that there was so much of the substance of the soil taken away every year, and that his land must therefore become impoverished. It is true that if he possessed such an amount of knowledge as might be expected to belong to an intelligent agriculturist, working upon rational principles, he should be able, upon reflection, to see that such ideas were entirely groundless. Nevertheless, the complaint is sometimes made, in a more or less vague manner, by persons who ought to know better; and even beekeepers appear to have occasionally adopted an apologetic tone, arguing that "bees do more good than harm," instead of having taken the much higher and only true stand by asserting that bees, while conferring great benefits on agriculture, do no harm whatever, and that the presence of an apiary on or close to his land can be nothing but an advantage to the agriculturist.

BENEFICIAL INFLUENCE OF BEES ON AGRICULTURE.

The value of the intervention of bees in the cross-fertilisation of plants is dwelt upon in Chapter III, "Australasian Bee Manual," third edition,

* This paper, which constituted the nineteenth chapter of the third edition of my "Australasian Bee Manual," was an attempt, and I have reasons for believing a successful attempt, to clear up several misunderstandings that had arisen in the minds of some farmers who had come to regard the working of neighbours' bees in their pasturage as detrimental to themselves, and to prove on the contrary that it is really to their interests to encourage beekeeping. Shortly after the paper was first published the subject was brought prominently forward in consequence of the action taken by a farmer in the United States to claim damages from a neighbouring beekeeper for alleged injury done to his grazing sheep by trespassing (?) bees. Needless to say, he lost his case. The paper has been extensively quoted in several American bee journals, and described as a "unique and valuable addition to bee literature." I trust it may still serve a good purpose in this country, where it first appeared.—I.H.

and the reader is referred for further information to the works of Sir J. Lubbock (Lord Avebury) and of Darwin. The latter, in his work on "Cross and Self Fertilisation of Plants," gives the strongest evidence as to the beneficial influence of bees upon clover-crops. At page 169, when speaking of the natural order of leguminous plants, to which the clovers belong, he says, "The cross-seedlings have an enormous advantage over the self-fertilised ones when grown together in close competition"; and in Chapter X, page 361, he gives the following details of some experiments, which show the importance of the part played by bees in the process of cross-fertilisation :—

Trifolium repens (White Clover).—Several plants where protected from insects, and the seeds from ten flower-heads on these plants and from ten heads on other plants growing outside the net (which I saw visited by bees) were counted, and the seeds from the latter plants were very nearly ten times as numerous as those from the protected plants. The experiment was repeated in the following year, and twenty protected heads now yielded only a single abortive seed, whilst twenty heads on the plants outside the net (which I saw visited by bees) yielded 2,290 seeds, as calculated by weighing all the seeds and counting the number in a weight of 2 grains.

Trifolium pratense (Purple Clover).—One hundred flower-heads on plants protected by a net did not produce a single seed, whilst one hundred on plants growing outside (which were visited by bees) yielded 68 grains' weight of seed; and, as eighty seeds weighed 2 grains, the hundred heads must have yielded 2,720 seeds.

Here we have satisfactory proof that the effect of cross-fertilisation brought about by bees upon the clovers and other plants growing in meadows and pasture-lands is the certain production of a large number of vigorous seeds, as compared with the chance only of a few and weak seeds if self-fertilisation were to be depended upon. In the case of meadow-cultivation it enables the farmer to raise seed for his own use or for sale, instead of having to purchase it, while at the same time the nutritious quality of the hay is, as we shall see further on, improved during the process of ripening the seed. In the case of pasture-lands, such of those vigorous seeds as are allowed to come to maturity and to fall in the field will send up plants of stronger growth to take the place of others that may have died out, or to fill up hitherto-unoccupied spaces, thus tending to cause a constant renewal and strengthening of the pasture. The agriculturist himself should be the best judge of the value of such effects.

The beneficial effect of the bees' visits to fruit-trees has been well illustrated by Mr. Cheshire in the pages of the *British Bee Journal*, and by Professor Cook in his articles upon "Honey Bees and Horticulture" in the *American Apiculturist*. In fact, even those who complain of bees cannot deny the services they render; what they contest is the assertion that bees do no harm.

CAN BEES HARM THE SOIL OR THE CROPS?

is, then, the question to be considered. The agriculturist may say, "Granting that the visits of bees may be serviceable to me in the fertilisation of my fruit or my clover, how will you prove that I am not obliged to pay too high a price for such services?" For the answer to such a question one must fall back upon the researches of the agricultural chemist, which will furnish satisfactory evidence to establish the two following facts: First, that saccharine matter, even when assimilated and retained within the body of a plant, is not one of the secretions of vegetable life which can in any way tend to exhaust the soil, being made up of constituents which are furnished everywhere in superabundance by the atmosphere and rain-water, and not containing any of the mineral or organic substances supplied by the soil or by the manures used in agriculture; and, secondly, that in the form in which it is appropriated by bees, either from the nectaries of flowers or as honeydew from the leaves, it no longer constitutes a part of the plant, but is in fact an excrement, thrown off as superfluous, which if not collected by the bee and by its means made available for the use of man would either be devoured by other insects which do not store honey, or be resolved into its original elements and dissipated in the air.

The foregoing statements can be supported by reference to authorities which can leave no doubt as to their correctness—namely, Sir Humphrey Davy in his "Elements of Agricultural Chemistry," written more than seventy years ago, and Professor Liebig in his "Chemistry in its Application to Agriculture and Physiology," written some ten years later, and the English version of which is edited by Dr. Lyon Playfair and Professor Gregory. These works, which may be said to form the foundation of a rational system of agriculture, were written with that object alone in view, and the passages about to be quoted were not intended to support any theory in favour of bee-culture or otherwise; they deal simply with scientific truths which the layman can safely follow and accept as true upon such undeniable authority, although he may be incapable himself of following up the processes which have led to their discovery or which prove their correctness.

SACCHARINE MATTER OF PLANTS NOT DERIVED FROM THE SOIL.

Liebig, when describing the chemical processes connected with the nutrition of plants, informs us (at page 4*) that—

> There are two great classes into which all vegetable products may be arranged. The first of these contain nitrogen; in the last this element is absent. The compounds destitute of nitrogen may be divided into those in which oxygen forms a constituent (starch, lignine, &c.) and those into which it does not enter (oils of turpentine, lemon, &c.).

* The edition to which reference is made is the fourth, published in 1847.

And, at page 141, that—

Sugar and starch do not contain nitrogen; they exist in the plants in a free state, and are never combined with salts or with alkaline bases. They are compounds formed from the carbon of the carbonic acid and the elements of water (oxygen and hydrogen).

Sir Humphrey Davy had already stated that, "according to the latest experiments of Gay Lussac and Thenard, sugar consists of 42·47 per cent. of carbon and 57·23 per cent. of water and its constituents." Now, Liebig in several parts of his work shows that the carbon in sugar and all vegetable products is obtained fr m carbonic acid in the atmosphere; and that "plants do not exhaust the carbon of the soil in the normal condition of their growth; on the contrary, they add to its quantity."

DERIVED FROM THE ATMOSPHERE AND RAIN-WATER.

The same authority shows that the oxygen and hydrogen in these products are derived from the atmosphere and from rain-water; and that it is only the products containing nitrogen (such as gluten or albumen in the seeds or grains), and those containing mineral matter (silex, lime, aluminium, &c.) which take away from the soil those substances that are required to be returned to it in the shape of manures. The saccharine matter, once it is secreted by the plant and separated from it, is even useless as a manure. Liebig says on this head, page 21,—

The most important function in the life of plants, or, in other words, in their assimilation of carbon, is the separation—we might almost say the generation—of oxygen. No matter can be considered as nutritious or as necessary to the growth of plants which possesses a composition either similar to or identical with theirs, because the assimilation of such a substance could be effected without the exercise of this function. The reverse is the case in the nutrition of animals. Hence such substances as sugar, starch, and gum, themselves the products of plants, cannot be adapted for assimilation; and this is rendered certain by the experiments of vegetable physiologists, who have shown that aqueous solutions of these bodies are imbibed by the roots of plants and carried to all parts of their structure, but are not assimilated; they cannot, therefore, be employed in their nutrition.

NECTAR OF PLANTS INTENDED TO ATTRACT INSECTS.

The secretion of saccharine matter in the nectaries of flowers is shown to be one of the normal functions of the plant, taking place at the season when it is desirable to attract the visits of insects for he purposes of its fertilisation. It may, then, be fairly asserted that the insect, when it carries off the honey from any blossom it has visited, is merely taking with it the fee or reward provided by nature for that special service.

SOMETIMES THROWN OFF AS SUPERFLUOUS.

There are, however, occasions when considerable quantities of such matter are thrown off or exuded by the leaves, which effect is taken to indicate an abnormal or unhealthy condition of the plant. At pages 106 and 107 of Liebig's book (speaking of an experiment made to induce the rising sap of a maple-tree to dissolve raw sugar applied through a hole cut in the bark) he shows that,—

When a sufficient quantity of nitrogen is not present to aid in the assimilation of the substances destitute of it, these substances will be separated as excrements from the bark, roots, leaves, and branches.

In a note to this last paragraph we are told that—

Langlois has lately observed, during the dry summer of 1842, that the leaves of the linden-tree became covered with a thick and sweet liquid in such quantities that for several hours of the day it ran off the leaves like drops of rain. Many kilograms might have been collected from a moderate-sized linden-tree.

And further on, at page 141, he says,—

In a hot summer, when the deficiency of moisture prevents the absorption of alkalies, we observe the leaves of the lime-tree, and of other trees, covered with a thick liquid containing a large quantity of sugar; the carbon of the sugar must, without doubt, be obtained from the carbonic acid of the air. The generation of the sugar takes places in the leaves, and all the constituents of the leaves, including the alkalies and alkaline earths, must participate in effecting its formation. Sugar does not exude from the leaves in moist seasons, and this leads us to conjecture that the carbon which appeared as sugar in the former case would have been applied in the formation of other constituents of the tree in the event of its having had a free and unimpeded circulation.

These quotations will probably be considered sufficient to justify the assertion that the gathering of the honey from plants can in no possible way tend to exhaust the soil or affect its fertility. There is no difference of opinion among scientific men as to the sources from which the saccharine matter of plants is derived. Since Liebig first put forward his views on that subject, as well as with regard to the sources from which the plants derive their nitrogen, the principles of agricultural chemistry have been studied by the most eminent chemists, some of whom combated the views of Liebig on this latter point (the source of nitrogen and its compounds), and Liebig himself seems to have modified his views on that point; but there has been no difference of opinion about the saccharine matter, as to which Liebig's doctrine will be found given unaltered in the latest colonial work on the subject, MacIvor's "Chemistry of Agriculture," published at Melbourne a few years ago.

SUPERFLUOUS NECTAR EVAPORATED IF NOT TAKEN BY INSECTS.

That the nutritive quality of the plants in any growing crop is not diminished by the abstraction of honey from their blossoms would appear to be evident from the fact already referred to, that those plants have actually thrown off the honey from the superfluity of their saccharine juices as a matter which they could no longer assimilate. There would appear, on the other hand, to be good reason to believe that the plants themselves become daily more nutritive during the period of their giving off honey —that is, from the time of flowering to that of ripening their seeds. This is a point upon which, I believe, all agricultural chemists are not quite agreed, but the testimony of Sir H. Davy is very strong in favour of it. In the appendix to his work already quoted, he gives the results of experiments made conjointly by himself and Mr. Sinclair, the gardener to the Duke of Bedford, upon nearly a hundred different varieties of grasses and clovers. These were grown carefully in small plots of ground as nearly as possible equal in size and quality; equal weights of the dried produce of each, cut at different periods, especially at the time of flowering and at that of ripened seeds, were "acted upon by hot water till all their soluble parts were dissolved; the solution was then evaporated to dryness by a gentle heat in a proper stove, and the matter obtained carefully weighed, and the dry extract, supposed to contain the nutritive matter of the plants, was sent for chemical analysis." Sir H. Davy adds his opinion that this "mode of determining the nutritive power of grasses is sufficiently accurate for all the purposes of agricultural investigation." Further on he reports, "In comparing the compositions of the soluble products afforded by different crops from the same grass, I found, in all the trials I made, the largest quantity of truly nutritive matter in the crop cut when the seed was ripe, and the least bitter extract and saline matter and the most saccharine matter, in proportion to the other ingredients, in the crop cut at the time of flowering." In the instance which he then gives, as an example, the crop cut when the seed had ripened showed 9 per cent. less of sugar, but 18 per cent. more of mucilage and what he terms "truly nutritive matter," than the crop cut at the time of flowering. From this it would follow that during the time a plant is in blossom and throwing off a superfluity of saccharine matter in the shape of honey the assimilation of true nutritive matter in the plant itself is progressing most favourably. In any case it is clear that the honey, being once exuded, may be taken away by bees or any other insects (as it is evidently intended to be taken) without any injury to the plant, by which it certainly cannot be again taken up, but must be evaporated if left exposed to the sun's heat.

QUESTION AS TO GRAZING STOCK.

There is, however, a plea put in by the agriculturist on behalf of his grazing stock, and one which he generally seems to consider unanswerable. He says, "Even if it be admitted that the removal of the honey from my farm is neither exhausting to the soil nor injurious to the plants of the standing crop, still it is so much fattening-matter which might be consumed by my stock if it had not been pilfered by the bees."

Now, it may at once be admitted that honey consists to a great extent of fattening-matter, though it may be allowable to doubt whether in that particular form it is exactly suitable as food for grazing cattle. Although it is quite true that the saccharine matter assimilated in the body of a plant tends to the formation of fat in the animal which eats and digests that plant, still one may question the propriety of feeding the same animal on pure honey or sugar. We may, however, waive that view of the subject, as we shall shortly see that it is only a question of such homœopathically small doses as would not be likely to interfere with the digestion of the most delicate grazing animal, any more than they would considerably increase its weight. Admitting, therefore, that every pound of honey of which the grazing stock are deprived by bees is a loss to the farmer, and therefore to be looked upon as a set-off to that extent against the benefit conferred by the bees in other ways, it will be necessary to consider to what extent it is possible that such loss may be occasioned.

QUANTITY OF HONEY FURNISHED BY PASTURE-LAND.

In the first place, it must be recollected that a large proportion—in some cases the great bulk—of the honey gathered by bees is obtained from trees, as, for instance, the linden in Europe, the bass-wood and maple in America, and in this country the forest-trees, nearly all of which supply rich forage for the bee, and everywhere from fruit-trees in orchards. A large quantity is gathered from flowers and flowering shrubs reared in gardens; from clover and other plants grown for hay, and not for pasture; and even in the field there are many shrubs and flowering plants which yield honey, but which are never eaten by cattle. Pastures, therefore, form but a small part of the sources from which honey is obtained; and in dealing with this grazing question we have to confine our inquiries to clovers and other flowering-plants grown in open pastures, and such as constitute the ordinary food of grazing stock. In order to meet the question in the most direct manner, however, let us assume the extreme case of a large apiary being placed in a district where there is nothing else but such open pastures, and growing only such flowering-plants as are generally eaten by stock. Now, the ordinary working-range of the bee may be taken at a mile and a half

from the apiary on all sides, which gives an area of about 4,500 acres for the supply of the apiary ; and if the latter consists of a hundred hives, producing an average of 100 lb. of honey, there would be a little more than 2 lb. of honey collected off each acre in the year ; or, if we suppose so many as two hundred hives to be kept at one place, and to produce so much as 10 tons of honey in the season, the quantity collected from each acre would be 4 lb. to 5 lb.

PROPORTION POSSIBLY CONSUMED BY STOCK.

Let us next consider what proportion of those few pounds of honey could have found its way into the stomachs of the grazing stock if it had not been for the bees. It is known that during the whole time the clover or other plants remain in blossom, if the weather be favourable, there is a daily secretion of fresh honey, which, if not taken at the proper time by bees or other insects, is evaporated during the midday heat of the sun. It has been calculated that a head of clover consists of fifty or sixty separate flowers, each of which contains a quantity not exceeding one five-hundreth part of a grain in weight, so that the whole head may be taken to contain one-tenth of a grain of honey at any one time. If this head of clover is allowed to stand until the seeds are ripened it may be visited on ten or even twenty different days by bees, and they may gather, on the whole, one, or even two, grains of honey from the same head, whereas it is plain that the grazing animal can only eat the head once, and consequently can only eat one-tenth of a grain of honey with it. Whether he gets that one-tenth grain or not depends simply on the fact whether or not the bees have exhausted that particular head on the same day just before it was eaten. Now, cattle and sheep graze during the night and early morning, long before the bees make their appearance some time after sunrise ; all the flowering plants they happen to eat during that time will contain the honey secreted in the evening and night-time ; during some hours of the afternoon the flowers will contain no honey, whether they have been visited by bees or not ; and even during the forenoon, when the bees are not busy, it is by no means certain that they will forestall the stock in visiting any particular flower. If a field were so overstocked that every head of clover should be devoured as soon as it blossomed, then, of course, there would be nothing left for the bees ; but if, on the other hand, as is generally the case, there are always blossoms left standing in the pasture, some of them even till they wither and shed their seeds, then it must often happen that after bees shall have visited such blossoms ten or even twenty times, and thus collected one or even two grains of honey from one head, the grazing animal may, after all, eat that particular plant and enjoy his one-tenth of a grain of honey just as well as if there had never been any bees in the field. If all these chances be taken into account it will be evident that out of the 4 lb. or 5 lb. of honey

assumed to be collected by bees from one acre of pasturage probably not one-tenth, and possibly not even one-twentieth, part could under any circumstances have been consumed by the grazing animals—so that it becomes a question of a few ounces of fattening-matter, more or less, for all the stock fed upon an acre during the whole season; a matter so ridiculously trivial in itself, and so out of all proportion to the services rendered to the pasture by the bees, that it may be safely left out of consideration altogether.

BEEKEEPING AS A BRANCH OF FARMING.

There is still one point which may possibly be raised by the agriculturist or landowner: "If the working of bees is so beneficial to my crops, and if such a large quantity of valuable matter may be taken, in addition to the ordinary crops, without impoverishing my land, why should I not take it instead of another person who has by right no interest in my crop or my land?" The answer to this is obvious. It is, of course, quite open to the agriculturist to keep any number of bees he may think fit; only, he must consider well in how far it will pay him to add the care of an apiary to his other duties. No doubt every one farming land may with advantage keep a few stands of hives to supply his own wants in honey—the care of them will not take up too much of his time, or interfere much with his other labours; but if he starts a large apiary with the expectation that it shall pay for itself, he must either give up the greater portion of his own time to it or employ skilled labour for that special purpose; and he must recollect that the profits of beekeeping are not generally so large as to afford more than a fair remuneration for the capital, skill, and time required to be devoted to the pursuit. In any case, he cannot confine the bees to work exclusively on his own property, unless the latter is very extensive. When such is the case, he may find it greatly to his advantage to establish one or more apiaries to be worked under proper management, as a separate branch of his undertaking; but in every case, whether he may incur or share the risks of profit and loss in working an apiary or not, the thing itself can only be a source of unmixed advantage to his agricultural operations, and consequently if he does not occupy the ground in that way himself he should be glad to see it done by any other person.

By Authority: John Mackay, Government Printer, Wellington.—1909.

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